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LOAVES FROM CANADIAN AND INDIAN WHEATS.

PUSA 12.

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Up to the year 1908, it was generally believed in the wheat trade that India could only produce wheats of relatively poor grain quality. This conclusion was a natural one, and was based on a long practical experience of the wheats exported from the country. In 1908 and succeeding years, a large number of Indian wheats were sent to England for complete milling and baking tests, the work being undertaken by Mr. A. E. Humphries, a former President of the Incorporated National Association of British and Irish Millers. These samples included many of the wheats of Northern and Central India as well as a large number of new varieties obtained at Pusa by selection and hybridization. The reports[1] on the behaviour of these kinds in the mill and bakehouse showed that, as far as the wheats of Northern and Central India are concerned, the current ideas as to the lack of quality in the Indian wheats of commerce were amply justified.

Many of the Pusa varieties, however, behaved quite differently and proved to be free milling and to yield flour and loaves of the same class as those produced from the strongest North American grades. The relation of the Pusa varieties to Manitoba wheat on the one hand, and to the present Indian wheats of commerce on the other, will be evident on referring to the Plate opposite.

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1 Howard and Howard, *Bulletins 14, 17, and 22, Agr. Research Institute, Pusa,* 1908, 1910, and 1911.

All these high quality wheats were originally obtained either by selection or hybridization among the large collections of Indian wheats made at Pusa in 1905 and subsequent years. Some of the best were found occurring naturally and in large proportion among the wheats commonly cultivated in North Bihar, but in these cases high grain quality was associated with low yielding power and poor straw. It is probably on account of their poor cropping power that these North Bihar wheats have not spread to other tracts in India. Nothing approaching high grain quality, however, was discovered in Central or in Northern India, although the wheats of the Punjab[1] were for the most part grown in pure culture at Lyallpur and afterwards thoroughly tested in England.

After the discovery of the fact that wheats with high grain quality existed in India, the aim of the selection and hybridization work at Pusa was to unite these qualities with yielding power, strong straw, rust-resistance and the capacity to ripen quickly with the minimum amount of soil moisture. On account of the trade preference for a white wheat, it was necessary to combine all the above desirable qualities in a white rather than in a red variety. Further, in the work of replacing the existing crop by an improved variety it would be an obvious advantage if the new wheats possessed some easily recognisable field character, such as colour of chaff, which would readily differentiate them from the crop as ordinarily grown by the people.

In one important respect the problem was greatly simplified. As is well known, wheat is an important food grain in India, and of the 8,000,000 tons produced annually about 90 per cent. is consumed in the country, the remainder being exported to Europe. Any improvement in the grain itself, to be of importance, must therefore satisfy both the Indian consumer and also the Home miller. It is fortunate that the class of wheat most liked by the people for food is that which is worth the most money on the Home markets. This is a most important point and one which cannot be emphasized too strongly. On many occasions, the Pusa wheats along with

[1] Howard and Howard, *Mem. of the Dept. of Agr. in India (Bot. Series)*, Vol. II, No. 7, 1909.

ordinary samples have been shown to cultivators, and they invariably prefer for their own food the kinds which have done best in the milling and baking tests in England. A number of landholders and educated Indians have eaten these new wheats and are loud in their praises of the superiority of these types over those which can be purchased in the Indian market. Every year at Pusa there is a great demand for any surplus wheat from the Botanical area, while at the Dholi and Bowarrah estates, where the new varieties are grown for seed on a large scale, a well marked preference for these wheats was at once shown by the people round about. At Dholi, the factory servants asked to be paid in wheat instead of in money.

The problem of producing wheats, characterized by high grain quality, high yield, improved straw, rust-resistance, and the power to ripen within the available growth period was eventually solved at Pusa. A number of wheats were produced, which, under experiment station cultivation, satisfied these conditions and were all that could be desired. At first sight, it might be thought that the whole matter was now settled and all that remained was to devise suitable methods of seed distribution. This, however, was by no means the case, and the present opportunity is taken of pointing out a very serious pitfall in variety trials carried out at experiment stations in India. This applies, in all probability, to other crops besides wheat and is likely to be of general interest. The agricultural conditions at a well-conducted experiment station are somewhat different from those which obtain among the ryots in the surrounding districts. The improved cultivation of the soil at an experiment station results in a greater supply of soil moisture for the wheat crop than is available in the average ryot's holding. It is likely, therefore, that a variety of wheat grown under the two sets of conditions will behave quite differently. This is found to be the case particularly if the maximum possible yield is desired at the experiment station. To obtain this maximum yield, the variety must be a late one so as to utilize to the utmost the available growth period and the ample supply of soil moisture. Under experiment station conditions, it is easily possible, with due

attention to cultivation, moisture conservation, and choice of soil to grow upwards of thirty maunds of wheat to the acre. If, however, these high-yielding varieties are grown by the cultivators quite different results are obtained. With defective preliminary cultivation and insufficient soil moisture, these late potentially high-yielding wheats do not reach maturity before the onset of the hot weather has begun to diminish the moisture in the soil. The result is a low yield, often of rather poorly filled grain. The experiment station results are thus reversed. Our experience at Pusa has shown that it is a good rule to avoid all high-yielding varieties with any tendency to lateness, and to confine attention to those sorts which ripen well within the available growth period. Such sorts, when grown under cultivators' conditions, have a margin of safety with which to meet the accidents of season. Experiment station results, therefore, must be used with caution, and considerable judgment is required in interpreting them. The highest yielding sorts are always apt to prove disappointing and the date of ripening and the appearance of the sample are perhaps more significant than the weight of the crop. These considerations explain the failure of Muzaffarnagar wheat among the cultivators in some tracts in the United Provinces and also that of Punjab Type 9 in the Punjab. It is true that both these varieties are capable of yielding heavily when the season is very favourable, if the supply of irrigation water is abundant and if the moisture-retaining capacity of the soil is all that can be desired. Such conditions for the wheat crop are the exception rather than the rule. It will be found that it is *that variety, which on the average does well, and in years of short moisture stands out from the rest,* and will be the one to select for general seed distribution.

The next subject investigated was the effect of environment on grain quality, an undertaking carried out in collaboration with Mr. H. M. Leake, the results of which have been published.[1] Briefly stated, it was found that in all the wheat-growing tracts of India, including the canal-irrigated tracts of the Punjab and the black

[1] Howard, Leake & Howard, *Mem. Dept. of Agr. in India* (*Bot. Series*), Vol. III, No. 4, 1910, and Vol. V, No. 2, 1913.

soils of the Peninsula, the quality of the Pusa wheats was maintained. In the case of Pusa 12, the milling and baking results obtained with the samples from the Indus Valley and the black soil areas were better than those given by the Pusa sample and those from other stations on the Gangetic alluvium. Canal irrigation was found to have no harmful effect on the grain quality, and in the case of Pusa 12 grown at fourteen stations all over India in 1912, the best loaves were given by the wheat from Lyallpur. The loaf produced from the Gurdaspur sample in that year is shown in Plate I.

During the progress of the environment experiments, a number of the Pusa wheats were grown in most of the wheat-growing tracts of India by the cultivators themselves. Practically all the varieties tried did well in Bihar, the United Provinces, and in Central India. One variety (Pusa 12), however, gave equally good results in the Punjab, the United Provinces, South Bihar, and the Central Provinces, and proved itself to be the best wheat for India as a whole, both as regards yield and quality. The results of the trials of Pusa 12 in the Punjab in 1914 are referred to by the Director of Agriculture as follows :—

"A special leaflet is being issued regarding Pusa 12, which has done well in the Punjab" (Punjab Agricultural Notes, *Pioneer*, June 13th, 1914).

In the United Provinces the results with Pusa 12 are thus summed up by the Director of Agriculture in "United Provinces Agricultural Notes for April," in the *Pioneer* of May 16th last :—

"This year a few selected Pusa wheats, which had done well at Cawnpore, were distributed in different parts of the Provinces, mainly in Oudh. Crop-cutting experiments were carried out to determine the yield in the cultivators' fields. The reports now to hand show that one of these, No. 12, has done uniformly well under diverse climatic conditions, equally favourable reports being received from Benares and Saharanpur. One of its most attractive

features is that it requires comparatively little irrigation and is therefore suited to the well-irrigated tracts. Some of the Co-operative Societies, whose members have grown it with success, are arranging to put it down on a large scale next year."

In Bihar, Pusa 12 is being distributed by the Agricultural Department in the south of the Province, while in North Bihar a large consignment of this wheat grown on the Belsund indigo estate was sold in April last to the Calcutta mills at a premium of four annas a maund over local wheat.

In the Central Provinces, the Pusa wheats have been tested for some years in the Eastern Circle both on the Government Farms and also by the cultivators. Mr. Clouston, the Deputy Director of Agriculture, in a letter dated April 7th, 1914, describes the result of these trials as follows :—

"We have decided now to grow Pusa 12 under the Ramtek Tank. We have given out seed for the last two years and the cultivators were well pleased with the outturns they got from it. It is a fairly early wheat and is therefore suitable for areas not commanded by irrigation. As an irrigated wheat it yields very well.

It has done well at Raipur too; we intend to distribute all the seed we have available on the Raipur Farm to wheat-growers in the Chhattisgarh Division.

Distribution of this variety will be taken in hand in earnest this year. I wanted to make sure that it was without doubt the best of those I have under trial before booming it."

The result of the trials of this wheat by the cultivators in most of the wheat-growing tracts of India leaves no doubt that this variety is eminently suitable for growth practically all over India. Pusa 12 has another advantage in addition to its yielding power and quality, namely, its characteristic appearance in the field which distinguishes it at once from the country wheats. The beardless ears are long, with shining red chaff, and the straw is quite different in tint from that of most Indian wheats. Its appearance in the field and the large elongated

grain enable this variety to be instantly distinguished. In any scheme of seed distribution, which aims at replacing the existing wheats by a new kind, it is a great advantage if the improved variety can easily be recognized in the field and in the market.

The results of the trials of Pusa 12 show that the time has come for the establishment of an improved grade of white wheat over a large area of the wheat-growing tracts of India. While the various existing seed distribution schemes with this wheat are being developed by the Agricultural Department, and while the amount of surplus seed of this variety for trade purposes is being multiplied, another side of the matter must be kept in view. The wheat must be brought to the notice of the Home millers in the form of one or two experimental shipments so that they may have an opportunity of getting first-hand experience of its qualities and behaviour. This is essential if this variety is to realize quickly its full value on the market. As is well known, wheats are bought largely on appearance and reputation. Indian wheats are known to possess poor quality, so that this reputation has to be overcome before an improved Indian grade can fetch its proper price. One or two shipments of the new wheat placed on the various markets and brought to the notice of the trade will obviously be the best means of convincing all concerned that an improved grade has really been obtained. By the time these preliminary shipments have been made, there should be sufficient Pusa 12 wheat in India for the shippers to begin to supply the demand. After this, the future development of the trade will depend on the efficient organization of the seed supply, a matter which can be left to the various Circle officers in the wheat tracts. In order to obtain the seed for the preliminary shipments, it has been arranged to concentrate the bulk of the seed of Pusa 12 raised on the Dholi and Bowarrah seed farms[1] in Bihar into a single Circle. The Central Circle of the

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[1] An account of the seed supply of the Pusa wheats was published in the *Agricultural Journal of India*, Vol. IX, p. 247, 1914. Seed of Pusa 12 and of the other Pusa wheats grown for distribution can be obtained on application to Mr. E. C. Danby, Dholi P. O., Bihar, or to the Imperial Economic Botanist, Pusa, Bihar.

United Provinces has been selected for the work and the co-operation of Mr. B. C. Burt, the Deputy Director of Agriculture, has been secured. This Circle has been chosen partly on account of the local development of the Co-operative Credit movement and of the close working arrangements which exist between the Societies and the Agricultural Department. By means of the Co-operative Societies, an effort will be made to replace the existing wheats as far as possible by the new kind and to supply the trade with as much surplus seed as can be obtained. At the earliest moment, this will be secured for the first shipments to Europe. In the work of buying in the seed and in placing it on the markets in Europe to the best advantage, the interest and assistance of Messrs. Ralli Brothers have been secured. Mr. A. E. Humphries has very kindly undertaken to bring the matter before the Home millers and to assist in the establishment of the new grade in England as soon as the first shipment has been collected.

CO-OPERATIVE CATTLE INSURANCE.*

BY

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INTRODUCTION.

THE material benefits to be derived from co-operation in agriculture are fully recognized in those countries where it has been adopted. It has been found to put fresh life into agriculture, and it has been particularly beneficial to the small farmer. Agricultural Co-operative Societies have been formed for a great variety of purposes. They provide credit, buy, sell, and distribute produce on favourable terms, store grain, improve the breeds of farm stock, and insure property against various kinds of risks. The last-named branch of usefulness in its application to cattle is the subject of this paper.

In India the loss of his oxen is very disastrous to the small agriculturist. Without draught cattle he cannot till his land or move his produce. Periodical famines and pestilences occur in addition to ordinary risk. The price of cattle has gone up and is not unlikely to increase further. To repair exceptional and unforeseen losses of cattle it may be necessary for the small farmer to pledge his credit. A more desirable solution is advocated. By means of a well-organized system of cattle insurance a man can, in exchange for a small premium, provide himself with the necessary funds to replace his animals. A Cattle Insurance Society working in conjunction with a Cattle Breeding Society is an almost ideal

* A paper read at the Co-operative Conference held at Poona in August 1914.

arrangement that may be brought about in due course in favourable localities.

It is proposed to commence by providing an economical system of insurance against losses of cattle by means of co-operation. There are other advantages to be derived from a system of this kind. Co-operation tends to create a bond of identical interests among the members of its societies. It teaches the value of mutual help and spreads education. A system of mutual insurance of cattle is bound to cause greater attention to be paid to the conservation of the lives of valuable animals. Public opinion demands that animals insured in a mutual society are properly housed, tended, and fed, and that every possible advantage is taken of scientific knowledge in regard to the prevention and cure of disease. A well-organized and efficient veterinary service is a necessary adjunct in any scheme of cattle insurance, and every society should realize the need of obtaining expert assistance and advice in the care and treatment of its insured stock.

It is proposed to describe shortly what has been done in other countries in regard to cattle insurance, and then to discuss the means at our disposal for instituting a scheme in the Bombay Presidency suitable to its special requirements.

Cattle Insurance in other Countries.

In many Western countries the success which has attended the formation of Co-operative Cattle Insurance Societies has been very remarkable. It is apparent from the available literature that in most places insurance was co-operative before it became commercial, and that as a rule it was conceived under Government supervision and with State assistance. Insurance has now become very general, and is exploited largely by Joint Stock Companies which insure against a great variety of risks. These organizations undoubtedly serve a useful purpose but as they are interested in making profits and spend considerable sums in managing expenses, which the insured has to pay for, they are not likely to appeal to the small agriculturist in the same way as co-operative insurance does. Joint Stock Companies are not usually very keen on live

stock insurance, as it entails considerable local supervision of a special character in order to prevent fraud. The consequence is that mutual live-stock insurance flourishes and appears likely to continue to do so.

Mutual cattle insurance exists in England, Germany, France, Italy, Austria, Norway, Sweden, Denmark, Holland, Belgium, and Switzerland. It is most developed in Holland, Belgium, France and those countries advanced in agriculture. In the small country of Belgium (11,373 square miles) alone there were in 1909 no less than 1,142 cattle insurance societies, comprising 101,709 members and insuring 294,583 cattle of an average value of Rs. 200 each. In addition there were 170 horse, and numerous goat and pig societies. In France in 1910 there were 8,428 cattle societies and 58 re-insurance societies. In Italy there are a very large number of societies, and federation is largely resorted to. In Germany there are over 8,400 societies, the majority of which are small local organizations.

" There is a consensus of opinion in Germany that this form of organization is the best. The members can observe and supervise the care given to insured animals, and the action taken when anything occurs, and it is to their interest to do so. They are also in a position, without incurring any appreciable expense, to estimate correctly the value of the animals both upon insurance and in case of loss. Its drawback consists in the fact that the risk is covered by too small a number of animals and in a too restricted area. Should numerous losses occur more or less simultaneously local associations may not be able to meet their obligations. It is considered advisable therefore for local societies to establish schemes of re-insurance, either by combining among themselves or by arrangements with large insurance undertakings or with the State."—(CAHILL.)

In some countries cattle insurance is State-aided and in some it is compulsory. In others the State organizes insurance by establishing institutions or federations (central societies) formed of the local mutual societies which adopt the model articles approved by the institution to which they are attached. A proportion of

the premiums received by the local societies is paid to the central society which bears the same proportion of the indemnities. In this way a wide tract of country is covered and the risks diffused.

A few years ago the Prussian Saxony Chamber introduced a system of re-insurance for the local associations in the Province. A number of these associations were formed into a union, and all with excess of receipts over expenditure had to pay the balance to the union for the purpose of covering the losses of those associations in contrary case.

Premium rates (tariffs) have to be fixed in accordance with the risks involved and the experience gained. In some cases compensation is not paid for animals lost from epidemic disease and in others certain diseases are excluded. The average mortality in Belgium in 1909 was 3·36 per cent., and the average rate of premium was 2 per cent. of the value. In that country epidemic disease is well under control and famine is unknown. In Burma, where there are some 50 societies, said to be doing well, a premium of 3 per cent. for plough cattle has been recommended, which is to be increased to at least 6 per cent. if rinderpest is included. In Bohemia the rate of premium is fixed every five years, based on the results obtained.

In most countries very young stock and old cattle are not accepted, and no indemnity is paid on insured animals that have died from the results of war, riot, rebellion, theft or loss by straying, fire, lightning, and flood. In Bohemia in the case of livestock insured for the first time the insurance only comes into force 15 days after valuation. This is a kind of quarantine to guard against disease in the incubative stage and appears to be very sound. Everywhere fraud on the part of the insuring member invalidates the insurance, and no compensation is paid if the death be clearly due to neglect.

In most cases all eligible healthy cattle of a member have to be insured and not merely a selection. This is to prevent fraud. Sickly beasts are excluded. To ensure that the owner will tend a sick animal properly and not let it die so as to obtain the insurance money, societies never pay the whole value, but a proportion,

varying from 60 to 70 per cent. Most societies fix a maximum value for which an animal may be insured. The owner states the value and this valuation is checked by the experts or committee, whose valuation holds good.

Valuations are checked every six months in some societies and altered if necessary before the half-yearly premiums are paid. In mutual insurance societies the officials give their services gratuitously but the Secretary may be paid a small sum. Every member joins for a year. After receiving any indemnity he must continue his membership for 3 years. In all cases a reserve fund is accumulated out of the balance left over after paying indemnities. When there is a reserve fund an entrance fee is usually charged to new members. Societies are always limited and therefore not responsible beyond their resources. If funds do not suffice a proportionate reduction in the indemnities is made all round.

In a few societies there is no common fund, but the owner of an insured animal is compensated when death occurs by levying a subscription on all the members to make up the value. This system is not favourably regarded by authorities on the subject of mutual insurance.

It is apparent that a system of cattle insurance by mutual co-operation in small localities is a most beneficial undertaking and not difficult of application, provided that the tariffs can be approximated to the liabilities. That desideratum has been successfully accomplished in Europe, and it remains to achieve the same result in India if possible.

The Application of Cattle Insurance to Indian Conditions.

Organized co-operation in India dates from 1904, when the Government of India passed Act X of that year "to encourage thrift, self-help, and co-operation among agriculturists, artisans, and persons of limited means, and for that purpose to provide for the constitution and control of Co-operative Credit Societies." This Act only dealt with the problem of credit, but the success that was attained opened up further possibilities.

In 1912 a new Act (II of 1912) called the Co-operative Societies Act, which was more comprehensive in its application, came into existence. The new Act applies not only to Credit Societies but also to Co-operative Associations organized for purposes of distribution, production, insurance, etc. Such Associations are required to be based on co-operative principles. It is not intended that they should become close corporations for the benefit of a few individuals. The new Act recognizes the existence of central societies for the express purpose of benefiting other societies of co-operative character. Simplicity and elasticity in rules passed under the Act are aimed at. It is recognized that it is essential to start cautiously and to progress gradually. Failures discourage, and instead of teaching the people to help themselves have the contrary effect.

It may be conceded that mutual cattle insurance on sound lines is very desirable in India, and it is now necessary to study the means of applying it successfully.

The construction of any scheme of life insurance requires for its foundation as correct an estimation of the death-rate as it is possible to make. The chances of saving life by practicable methods have to be calculated at the same time. In India the absence of accurate and complete statistics in regard to the mortality of cattle complicates the situation. Epidemic disease is common and is so irregular in its incidence and in its effects that, even when statistical information is available, the prospect of an exceptionally unfavourable outbreak has to be considered and if possible provided for.

Relief in the shape of advice and treatment is the duty of the Veterinary Department. Its scope is somewhat limited at present, owing to its numerical inadequacy and the unwillingness of the more ignorant to take advantage of its assistance. Modern methods of controlling and preventing the spread of disease are not always popular, as they frequently entail individual inconvenience. There is hope for the future, however. It is the expressed policy of Government to provide more veterinary assistance gradually, and there are distinct signs that the people themselves are inclined to welcome the work of the Department. As already stated the

educative value of co-operation is a great factor in enlightenment. The Department has at its disposal the means of providing relief in many cases. In the absence of effective legislation the public spirit of individuals is looked for to enable them to be carried out. When the funds of a community or society are likely to be affected, it is expected that wholesome pressure will be brought to bear on individual members who, from prejudice or indifference, are not inclined to take advantage of measures for the public good.

It is obvious that if epidemic disease is to be included in the risks undertaken by insurance societies in India, the tariffs will usually have to be rather high as compared with countries where it is not so serious, and where in many cases compensation is given by the State. In Burma, as already stated, rinderpest is excluded as a rule. If it is included a high tariff is required.

Although many authorities are very adverse to inordinate risks being taken in any scheme of cattle insurance, the writer considers that it would be a mistake to exclude epidemic disease in India except in particular instances which will be mentioned later. Unless the risk of epidemic disease is included the benefits of insurance would be greatly minimized. Such a provision will be of real help to the people, and if successful popularize it greatly.

There are other difficulties in the way of exclusion also. If one or more diseases are excluded differences of opinion in diagnosis are bound to occur, which would probably lead to considerable friction. Even professional men are capable of making mistakes in diagnosis, and this factor might easily lead to difficulties. In India some outbreaks of epidemic disease are very mild in character and simulate death from natural causes or ordinary non-infective disease.

A short account of a few main features connected with the principal cattle diseases as they affect insurance may be useful.

The principal epidemic diseases to which cattle are liable in India are rinderpest, hæmorrhagic septicæmia, anthrax, black-quarter, and foot and mouth disease.

Rinderpest is a disease which may cause extensive mortality, and as a rule attacks all the cattle in the locality that are not im-

mune. In the plains about 50 per cent. of those attacked die, and in the hills the mortality is often as much as 90 per cent. For that reason it would be unsafe to bring cattle in hilly tracts into any scheme of insurance at present. Such are not very valuable animals as a rule. Young animals die more frequently than old ones, and the mortality rate can therefore be lowered if they are excluded. Preventive inoculation can be performed in this disease. With the usual method adopted protection for a short time only is given. Early information to the Veterinary Department and the acceptance of its remedial measures will result in the death-rate in this disease being greatly reduced.

Hæmorrhagic Septicæmia is a very serious disease in some localities. It attacks buffaloes mainly. For that reason it is doubtful if these animals ought to be invariably accepted. This disease is periodical in many places and the mortality of animals attacked is usually about 90 per cent. It does not go through a herd like rinderpest, however, and draught bullocks do not appear to be very susceptible. A good deal can be done to prevent its occurrence by attention to sanitation and the provision of a clean water-supply. Preventive inoculation can be practised, but the peculiar nature of the disease in respect to its occurrence rather depreciates the practicability of the method.

Anthrax occurs in some districts, principally in the Carnatic. It is sometimes confused with the last-named disease. It is not usually seen in buffaloes. In other respects the remarks under hæmorrhagic septicæmia regarding mortality and prevention apply.

Black-quarter mainly affects young animals up to four years of age. The areas in which it occurs can usually be specified. The risk of adult animals becoming diseased may be accepted, except in notoriously bad places. Vaccination against this disease is frequently practised.

Foot and Mouth Disease causes more inconvenience than mortality.

Diseases due to external and internal parasites may be regarded as epidemic diseases also. Exceptional mortality from them is rare in adult cattle. Errors of diet, accidental poisoning, and such

like are fair risks, provided no excessive carelessness can be proved.

The risk of famine must be taken. In such an event Government assistance and private charity might be invoked justifiably.

In view of the above it is obvious that the fixation of an equitable tariff is a problem involving some difficulty. Local conditions must be carefully considered. A great deal must depend on the intelligence and foresight of the organizers. It is obvious that it would be extremely short-sighted to start a society in a locality subjected to periodical epidemics of a serious nature. It is not usual to find a good class of cattle in such places. It does not seem worth while to start a society unless the cattle are fairly valuable. The inclusion or otherwise of buffaloes is a matter for serious consideration in a locality where hæmorrhagic septicæmia occurs periodically.

It is recommended that except in special cases the risk from epidemic disease be undertaken. Should unforeseen or exceptional mortality occur in the early days of a society it would be very unfortunate, and liquidation might result. In that case a *pro-rata* distribution of funds would have to be made, and so long as this was done fairly no great harm would have been done. The remaining cattle would probably have attained a high degree of immunity, rendering them insusceptible to that particular disease at any rate. If confidence could be restored the society could be started again with that much in its favour. Every society that could tide over the first few years successfully without a serious epidemic to deplete its resources would be able to build-up a reserve fund and would then be in a strong position.

It is suggested in the model By-laws which are appended to this paper that a tariff of 5 per cent. on the value of each animal be levied. This premium is intended to cover risks from epidemic disease, subject to certain conditions mentioned in the By-laws. It is for members of societies to decide, after mature consideration in the light of their experience of the local conditions, if the rate is suitable.

It is considered advisable to limit insurance to certain classes of cattle until further experience has been gained. In India draught cattle receive most care and attention and they are most easily identified.

Immature and very old animals should be excluded. A suitable limitation of age, to commence with at any rate, is from four to twelve years.

The simplest way to age an animal of four years old is by its teeth. In India the permanent lateral incisor teeth are generally cut at about $3\frac{1}{2}$ years old and are in wear at 4 years, *i.e.*, at 4 years old the animal has 6 permanent incisor teeth and 2 milk-teeth. It is not possible to tell the age by the teeth with accuracy after 6 years old, but a rough estimate may be made. When there is any doubt about an animal being under or over 12 years it would be wise to exclude.

Some safeguard against the possibility of an indemnity having to be paid for an animal that had the seeds of disease in it at the time of examination and valuation is necessary. The model By-laws provide for this (By-law 3). They also provide for the exclusion of certain risks which no society or company ever undertakes except under special terms (By-law 4). The owner of an animal must adopt necessary prophylactic and remedial measures and legitimate pressure should be brought to bear on him if he is obstructive. To guard against dishonest practices a proportion of the value of an animal should be paid only and a maximum sum fixed. In course of time it might be possible to relax the stringency of some of the conditions.

No society should be started unless at least 100 cattle are to be insured, and there should be at least ten members. Large societies with many members are not indicated, however. It is necessary to keep down the expenses of administration, and it is very important that all insured animals should be under the eye of the society to avoid fraud. The scope of a society should be restricted to the village area therefore.

The valuation committee has most important duties to perform. The members must give their services gratuitously to keep down

expenses. When a society is confined to one village the work is not onerous. The secretary may be paid a little as he has to keep the books of the society. The success or failure of a society will depend to a great extent on the efficiency of its valuation and managing committees. When a death occurs one or more members of the valuation committee must see the carcass and give the necessary certificate. The managing committee have to supervise the decisions of the committee of experts and verify them when there is any doubt on either side. They have also to make any sanitary regulations that are necessary, and see that all insured cattle are properly looked after. If feasible, new purchases should be segregated for ten days before they are allowed to mix with the village herd to avoid the risk of epidemic disease. Itinerant cattle dealers should be obliged to keep their cattle away from villages. Their herds are frequently infected with disease and responsible for spreading it. Indemnities should be paid as soon as possible, but in the case of epidemic disease a little delay is advisable for two reasons, one being that in serious epidemics a *pro-rata* distribution of funds may be necessary, and the other, that it is better to put off the replacement of animals for some time when a village has been infected with epidemic disease.

Accounts must be kept methodically. Convenient forms will, no doubt, be prescribed by the Registrar to suit the By-laws which may finally be settled.

Conclusion.

It is hoped that mutual cattle insurance societies will soon be started in the Bombay Presidency.

The model By-laws which form an appendix to this paper have been drafted in collaboration with Mr. Ewbank, the Registrar of Co-operative Societies, and the Burma scheme has been freely adopted.

Any group of cattle owners desiring to form a society should first consult the Registrar or Local Honorary Organizer, who will visit the village. An informal meeting of persons owning altogether not less than 100 cattle should be called, and after making such

alterations in the model By-laws as are necessary to suit local conditions, at least 12 of them should sign two copies of the proposed By-laws and submit them to the Registrar in the form prescribed by Government. Societies should not be started unless there is a veterinary dispensary in charge of a veterinary assistant in the neighbourhood, *i.e.*, in the Taluka or within ten miles.

Eventually Central Societies will be formed, no doubt. Not less than twenty societies should be federated for this purpose. It would be advisable in this case to cover a large area, or, better still, for a proportion of societies in several detached districts to combine. In this way the financial risk attending a serious outbreak of disease or famine in any one district would be minimized. The success of mutual cattle insurance in India must obviously be somewhat problematical for the present, as it will depend so much on the fortune attending the early history of societies. Care in fixing the tariff and caution in selecting areas are strongly indicated. Every advantage should be taken of modern methods of preventing and curing disease, and great attention should be paid to the hygienic conditions under which insured animals are kept. The formation of Central Societies should eventually make for security. It is expected that progress will be slow at first, and indeed that is desirable. The experience gained by the older societies will be very valuable to the younger ones.

The small agriculturist has a lot to gain and very little to lose from a well-organized system of cattle insurance. Something will have been achieved if this paper clears the way by bringing about constructive criticism and the writer will feel that he has been amply rewarded.

Appendix.

Model By-laws for a Co-operative Cattle Insurance Society.

1. The society shall be called The .... Cattle Insurance Co-operative Society, Limited. Its registered address shall be..............................

2. The object of the society is to provide for its members an indemnity in case of the loss of draught cattle by death from disease or accident.

Scope and Conditions of Insurance.

3. The society will accept for insurance healthy bullocks and male or female buffaloes between the ages of 4 and 12 years. Any animal may be admitted that has six permanent incisor teeth.

In the case of animals insured for the first time the insurance will not come into force until 10 days after valuation and registration.

4. The society will pay indemnities for the death of all animals except those dying from the following causes:—

(*a*) War, riot, and rebellion.

(*b*) Theft or loss by straying.

(*c*) Journey by railway.

(*d*) Act of a third party who is legally liable to pay compensation to owner.

(*e*) Contagious disease, where the member has failed to carry out any prophylactic or curative measures advised by the Veterinary Department, provided that they have been accepted by the committee and communicated to the owner by it in writing.

5. The indemnity payable shall be two-thirds of the value of the animal as fixed at the last annual valuation, subject to the provision that it shall in no case exceed Rs. 100.

6. The owner is bound to inform the committee of all cases of illness as quickly as possible, and to carry out its suggestions for treatment.

7. If the committee think veterinary assistance necessary they may call in the veterinary assistant. If they are required by the Superintendent, Civil Veterinary Department, to pay the expenses of the visit, the amount shall be borne equally by the society and the member.

Membership.

8. Membership of the society shall be confined to residents in the village.

9. All respectable persons, above eighteen years of age, who own plough cattle in the village are eligible for admission. The application for membership must be signed by the member and approved by a majority of the committee. An entrance fee of Re. 1 must be paid.

10. A member must continue to belong to a society at least for two years after he receives any indemnity from it, provided that he continues to own cattle in the village.

11. A member may resign his membership, with the approval of the committee, after three months' notice, provided that he has first discharged all his liabilities to the society.

12. A member may be expelled by the committee subject to appeal to the next general meeting for ill-treatment of cattle, fraud, or deceit, or breaking rules, or refusing to carry out the sanitary orders of the committee.

13. On the withdrawal or expulsion of a member any policy held by him is immediately rendered void.

Valuation.

14. An owner wishing to insure any of his cattle shall declare the age, value, and description of the beast ; deceit in this declaration, if it misleads the valuation committee, will invalidate the insurance.

15. The value of each beast accepted for insurance shall be fixed annually by the valuation committee [appointed under By-law 34 (*b*)]. The age shall be fixed on admission and shall be subsequently indisputable.

16. All insured cattle shall be branded with the society's mark on the right fore foot and their description registered.

17. Animals in bad condition or of more than 12 years of age shall be refused admission, or, if already insured, re-insurance at the end of the year, provided that if any animal rejected under this rule dies within one month of the date of rejection, the owner shall receive three-fourths of the indemnity that would have been payable immediately before the rejection.

18. Animals bought to replace animals sold can be substituted, provided their value is practically the same.

19. No refund of premium is allowed if the animal insured is sold by the owner. The policy will continue in force provided that the animal is not removed from the village.

20. The valuation committee shall not value their own cattle. This shall be done by the managing committee.

Funds.

21. The annual premium shall be 5 per cent. of the value of animals as annually determined by the valuation committee. The premium shall be payable in advance in two half-yearly instalments, on April 1st and October 1st.

22. If any premium is overdue by more than 30 days the policy lapses and the member can get no indemnity.

23. If a member wishes to move any insured beast for more than 7 days not less than 10 miles beyond the limits of............, he is bound to inform the managing committee and to pay such enhanced premium (if any) as it may fix.

24. The funds of the society shall be :—

(1) The general fund, *i.e.*, the amount paid on account of premia during the previous and current year.

(2) The reserve fund which shall consist of :—

(*a*) Fines.

(*b*) Entrance fees and donations.

(*c*) Net balance for the year before last remaining over after paying all dues.

(*d*) Interest on any sum invested.

25. At least half of the reserve fund shall be deposited on one month's notice in the Bombay Central Co-operative Bank. The remaining funds shall be kept in the Post Office Savings Bank.

26. The reserve fund can be used for paying indemnities only with the approval of the Registrar after the general fund has been exhausted.

27. The liability of members is strictly limited to the amount of premiums payable by them under By-law 21.

Indemnities.

28. The owner of a beast which has died must inform the secretary of the society of the fact of death within 24 hours. He must produce the carcass before a member of the valuation committee within 48 hours of death, and must answer truly all questions put to him.

29. The indemnity will be payable at the next quarterly meeting of the managing committee after death has been certified by the valuation committee, provided that the claim is admitted.

30. The member may dispose of the skin and carcass.

31. If the funds of the society (both reserve fund and general fund) are exhausted, indemnities for all deaths during the quarter must be proportionately reduced.

The General Meeting.

32. At the commencement of each year (April 1st) a general meeting shall be held. Its duties shall be :—

(*a*) To elect a managing committee of seven members.

(*b*) To elect a valuation committee of three expert members.

(*c*) To receive the balance sheets of the previous year as prepared by the managing committee, and to pass them.

(*d*) To consider the audit note and any communication received from the Registrar or any suggestions made by members.

(*e*) To hear and to dispose of appeals.

(*f*) To appoint a secretary and to fix his pay and bonus (if any).

The Managing Committee.

33. The Managing Committee of seven members, of which three are a quorum, shall perform the following duties :—

(*a*) To hear and decide appeals from decisions of the valuation committee.

(*b*) To elect its own chairman, whose services shall be gratuitous.

(*c*) To supervise the treatment of the animals insured.

(*d*) To make sanitary rules which shall be binding on the members and to fine members sums not exceeding Re. 1 for infringements.

(*e*) To check the accounts, and to see that no defaults in the payment of premia are allowed.

(*f*) To authorize the secretary to pay indemnities after considering claims.

(*g*) Generally to carry on the business of the society.

34. The managing committee shall meet at least once a quarter.

Disputes.

35. Disputes between the society and a member shall be settled by arbitration, the arbitrator being appointed by the Auditor of Co-operative Societies in charge of the society. The decision of the arbitrator shall be final and not removable in any Court of Law.

Signatures.

SOME OBSERVATIONS ON UPPER BURMA PADDY (GROWN UNDER IRRIGATION).

BY

E. THOMPSTONE, B.Sc.,

Deputy Director of Agriculture, Northern Circle, Burma.

Introductory.

It is now six years since classification of, and experiments on, Upper Burma paddies were commenced on the Mandalay Experimental Station ; and it is over four years since improvement, chiefly by selection, of some of these paddies was begun.

A rough botanical classification was issued in the form of a Bulletin in 1911 after which classification work was discontinued for a time. But later it was deemed by the Provincial Agricultural Conference, at the instigation of the Agricultural Chemist, to be of considerable importance, and in consequence the work was resumed on slightly different lines. An economic classification of all the principal varieties is in progress, and the Assistant Botanist has made such headway that it is hoped that in a short time it will be brought to a satisfactory conclusion. This classification is based on those important agricultural and botanical characters which underlie the problems of rice improvement and of increase in yield ; and at the present time if any particular type of paddy is required, for improvement, selection, or any other purpose, it can be obtained by reference to the standard collection, the name of the variety, and the locality from which it was originally collected.

An account of the experiments and also an abbreviated statement of some of the selection work may be found in the Mandalay Farm Reports.

During the course of this classification, experimental and improvement work, many difficulties and problems were met with—difficulties which, at that time, had not been overcome by any work published by any of the Agricultural Departments in India. Consequently in the absence of an Agricultural Botanist an attempt was made to solve some of them for ourselves as far as compatible with the work on hand. The observations set forth below have therefore been the results of work which, though of secondary importance, was none the less essential to progress. Though the writer does not lay claim to finality in his conclusions, the observations have been carefully made and some of them have already proved to be extremely helpful in carrying out the principal tasks now engaging attention.

Results such as those obtained by the Economic Botanist, Bengal,[1] have gone far to solve some of the problems. Yet it is hoped it will not be superfluous to include in this note observations obtained in a different way and almost entirely before this publication appeared. Those figures which may be on the same lines as any which have been already published will at least strengthen the conclusions arrived at.

Some of the principal problems of paddy cultivation in Burma have been set forth by the Deputy Director of Agriculture, Southern Circle, Burma,[2] and they are to all intents and purposes the same for Upper as for Lower Burma—except that owing to different conditions some of them are probably even more accentuated in the former area. There is, therefore, little need to detail them here or to call attention to the many difficulties which beset the person who attempts to solve these problems. It must, however, be remembered that the conditions under which paddy is grown in Upper and Lower Burma differ. In the former the conditions are dry and irrigation is in most places resorted to, whilst in the latter

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1 Hector, G. P. "Notes on Pollination and Cross-fertilization in the common Rice plant, *Oryza sativa*, Linn." *Mem. Dept. of Agri. in India, Bot. Series*, Vol. VI, No. 1, June, 1913.

2 McKerral, A. "Some Problems of Rice Improvement in Burma." *Agri. Journal of India*, Vol. VIII, Pt. IV, October, 1913.

country the rainfall is very heavy—sufficient for the crops, and the atmosphere during the growing season almost always very full of moisture. Whether this will make a difference in the general behaviour of the plant remains to be seen. It certainly makes a difference in the variety most suitable ; for in Upper Burma those varieties which generally succeed best in the irrigated areas are seldom the most successful in an entirely rain-fed tract and *vice versâ*. The soil also, apart from the water-supply, not only determines the variety but, according to the cultivator, the time and method of planting.

There are four practically distinct crops of paddy, divided and named according to the season of growth, *viz.* :—

I. *Kaukyin* (sometimes called *Kauksaw* or *Kauklat*) or early paddy sown about the month of June, *i.e.*, very early in the rains, and harvested in October. This is often called autumn rice.

II. *Kaukgyi* sown July to September and harvested from early December to end of January. This, sometimes called "Winter rice," is the main or principal crop, occupying about ninety-five per cent. (more than nine and a half million acres) of the total area under paddy in Burma and forming the principal, almost the only, source of export paddy and rice.

It is on this crop grown under irrigation that the observations herein recorded have for the most part been made.

III. *Mayin* paddy is sown in December and January and reaped in May and June.

IV. *Kaukti* paddy is sown (usually broadcast) about the end of March or during April and reaped in June or July. The *Kaukti* crop is of least importance.

These two crops, *Mayin* and *Kaukti*, are almost always of the "Kaukkyan" or non-glutinous varieties of rice. They are the principal crops grown round the edges of *Ins* or lakes and other places where they are planted, or quite commonly sown broadcast, in fields as the water recedes or dries up during the hot weather. The *Mayin* crop is of considerable importance covering an area of nearly 90,000 acres.

Many varieties of paddy are capable of growing quite well either as *Kaukyin* or as *Kaukgyi*; but only very few are found to succeed both as a *Kaukgyi* and as a *Mayin* paddy.

In the first two classes, *Kaukyin* and *Kaukgyi*, are to be found both glutinous (*Kaukhnyin*) and non-glutinous (*Kaukkyan*) rices, with grades of semi-glutinous rices between. The non-glutinous varieties are, however, by far the most important as well as the most numerous; and it is with varieties of non-glutinous *Kaukgyi* that almost all this work has so far been carried out.

The Improvement of the Race.

The work of plant improvement being carried on at the present time is largely based on the now almost universally accepted principle that in the ordinary field of any farm crop there exists an indefinite number of "elementary species" which, when isolated and grown separately, are found to breed true so long as they are kept free from external contamination. Practically every cultivator's field of paddy in Upper Burma contains a mixture of two or more varieties (and generally also many hybrids) which can readily be observed and selected. There is no need to grow them separately to show that they are of different varieties. But if one of these varieties, consisting of individuals of similar external appearance, be grown it can by a little experiment and some tedious work be proved that, like Johannsen's beans, the variety is composed of a number of elementary species or strains, and that by selecting the best "pure line" an improvement in the race can quite readily be effected.

The characters of plants dealt with are concerned chiefly with yield and the laws governing yield—these, owing to the condition of the rice trade and the consequent indifference of millers towards quality, being of primary importance. So long as the miller obtains fairly clean sample of bold grain of regular size and shape free from admixtures of awned and red grains he is quite satisfied and is unwilling to pay for any improvements in quality. In fact good and bad paddy frequently obtain the same market

rates, the only difference being that due to "poundage"—an allowance made according to the weight per basket. Hence there is little wonder that the cultivator has an eye to crop outturns only. The question of quality has, therefore, received scant consideration here, and the improvement in yield of those strains conforming to the trade requirements given above has been the writer's chief aim.

Of the observations made the following three are most easily reduced to the form of frequency curves and will serve to show that even where varieties are not mixed plants vary considerably and are susceptible of improvement by selection. They also throw some light on the inheritance of yielding power in some strains of paddy.

1. *The number of grains per plant.*—Two of the purest cultivator's varieties of paddy obtainable were taken for selection purposes and the seed (previously hand-selected) was sown in the ordinary way. The plants were transplanted singly at one foot apart each way and the number of seeds produced by many of the plants was counted. In the case of *Kalagyi* paddy, diagram I. represents the result of 2,720 countings. In diagram II. the result of counting the seed produced by 840 plants of *Ngaseingyi* is depicted.

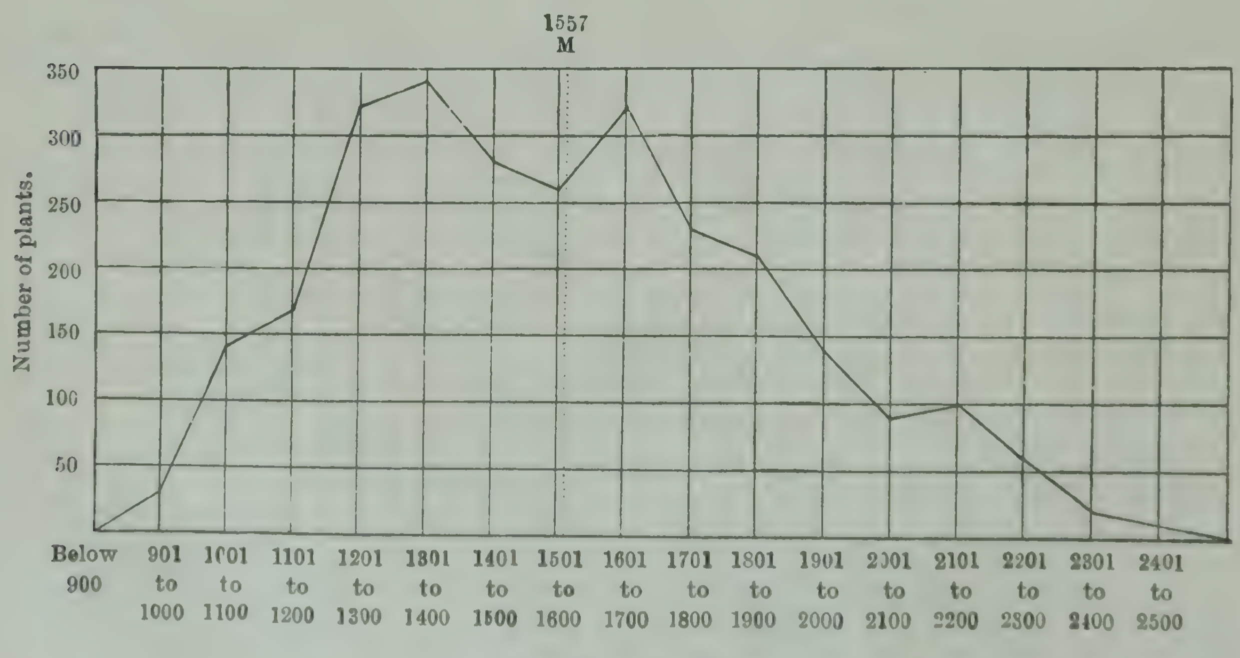

DIAGRAM I—(*Kalagyi* paddy).

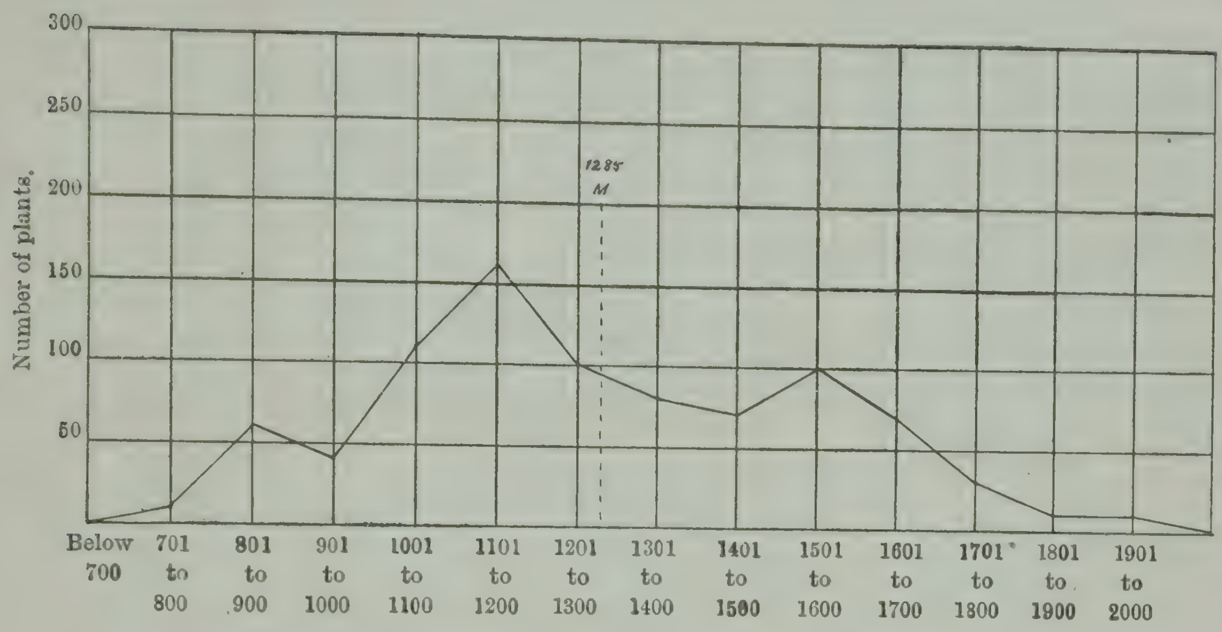

DIAGRAM II—(*Ngaseingyi* paddy).

The curves are somewhat flat owing to the small number of countings made and to the narrowness of the groups. By making groups of 200 instead of 100 seeds the curves become very much steeper. They, however, serve their purpose in showing where the "mode" or highest frequency of each of the varieties lies—that of *Kalagyi* at 1,300-1,400 grains per plant and that of *Ngaseingyi* at 1,100-1,200 grains per plant—and also in showing the range of variation. Ordinary *Kalagyi* paddy produces from 900 to 2,500 seeds per plant and ordinary *Ngasein* from 700 to 2,000 seeds. The mode indicates the *prevailing type* of grain and is of great importance especially to the breeder who wants to produce grain having any particular characteristics or to the man who is endeavouring to "fix a type." Such breeders will select with reference to the prevailing type, but what we are most interested in, as breeders of high-yielding paddy, is not the mode or the range of variation, but the average production of the whole population of plants, that is the "*mean*" (marked M) or arithmetical average. It can be seen approximately where this lies by looking at the diagrams. In diagram I. it lies a little above 1,500 grains per plant (actually 1,557) and in diagram II. between 1,250 and 1,300 grains per plant (actually 1,285). To obtain the mean accurately we multiply each value by its *frequency*, add the results, and then divide the sum

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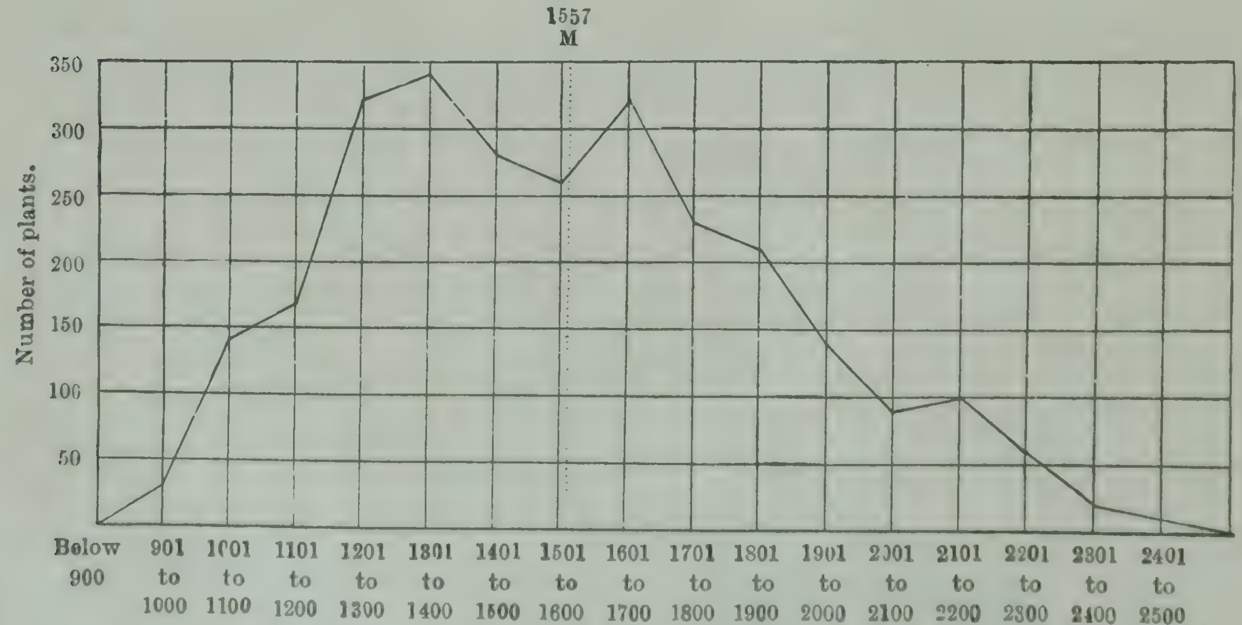
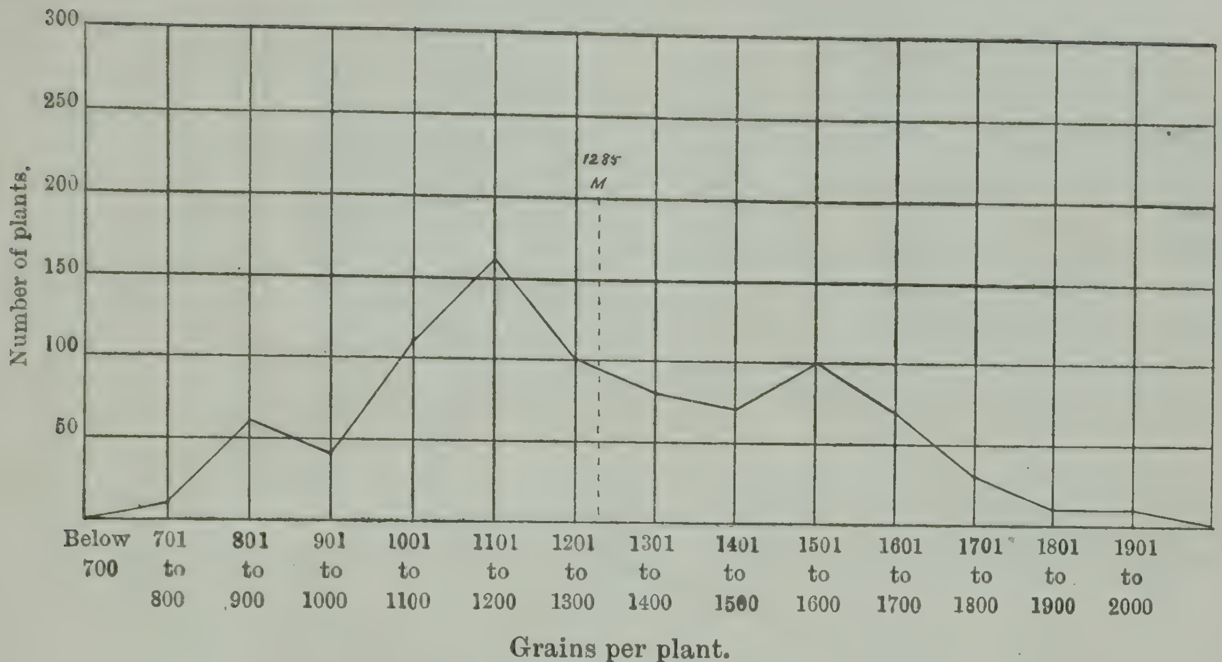


Grains per plant.
DIAGRAM I—(*Kalagyi* paddy).



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by the number of individuals, or as they are called "variates." For the purpose of this paper, however, the approximate "means" are sufficient, and it may be unnecessary in every case to go through the long calculations required to secure the accurate figures. From the mean a very good conception is obtained of the *average type* of paddy under consideration so far as this particular character is concerned, and it is this type which is of greatest importance to us.

Let us now see what takes place when line breeding is carried out. A number of single plant selections were made and sown and planted in the same way the following year. It was not possible to make a very large number of countings as should have been done to obtain more accurate data, but the six pure lines (A to F) of *Kalagyi* depicted in diagrams III and IV are representative of those data which were taken. They are drawn to the same scale as diagram I for comparison and in consequence of the smaller number of variates (about 1,000 only in each case) the curves appear somewhat flat. As, in making selections of plants for breeding purposes, the worst were carefully avoided, it is quite probable that the differences could have been more accentuated by including in our pure lines some of the poorer specimens. They are, however, sufficiently pronounced to illustrate the variability or deviation of the pure lines from the original type and from one another.

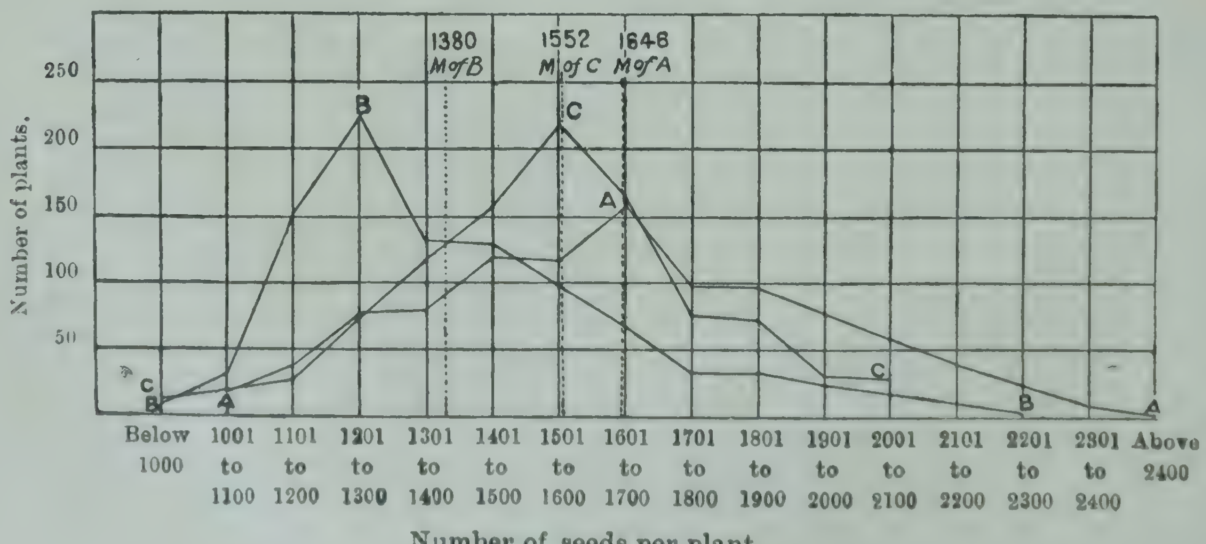


DIAGRAM III.

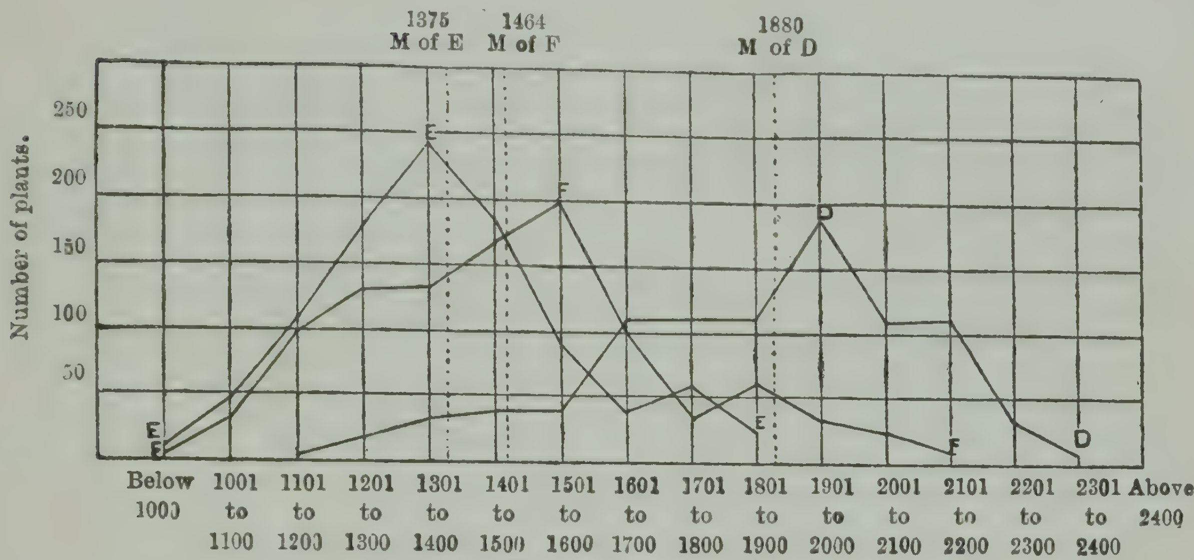


DIAGRAM IV.

Compare these diagrams with diagram I. In diagram III, the mean of the plants of pure line A falls between 1,600 and 1,700 (actually at 1,646) and this is somewhat higher than the mean of the original (diagram I). The mean of the plants of line B, on the other hand, falls between 1,300 and 1,400 (actually at 1,380) which is much lower than that of the original, and the mean of the plants of line C falls at 1,552 which is almost identical with that of the original paddy. Turning to diagram IV, the mean of the plants in pure line D falls at 1,880, that of the plants of line E at 1,375, and that of those of line F at 1,464. These means are respectively much higher, much lower, and slightly lower than the mean of this original paddy mixture.

These results very closely conform to those obtained by weight from the variety testing plots.

Table of comparison.

(In order of "Mean.")

Paddy.	Mean of seeds per plant.	Yield per acre. (Average of 5 trials.)
Line E	1,375	3,754 lbs.
,, B	1,380	3,708 ,, *
,, F	1,464	3,820 ,,
,, C	1,552	4,053 ,,
Ordinary hand-selected.	1,557	3,925 ,, *
Line A	1,646	4,063 ,, *
,, D	1,880	4,493 ,, *

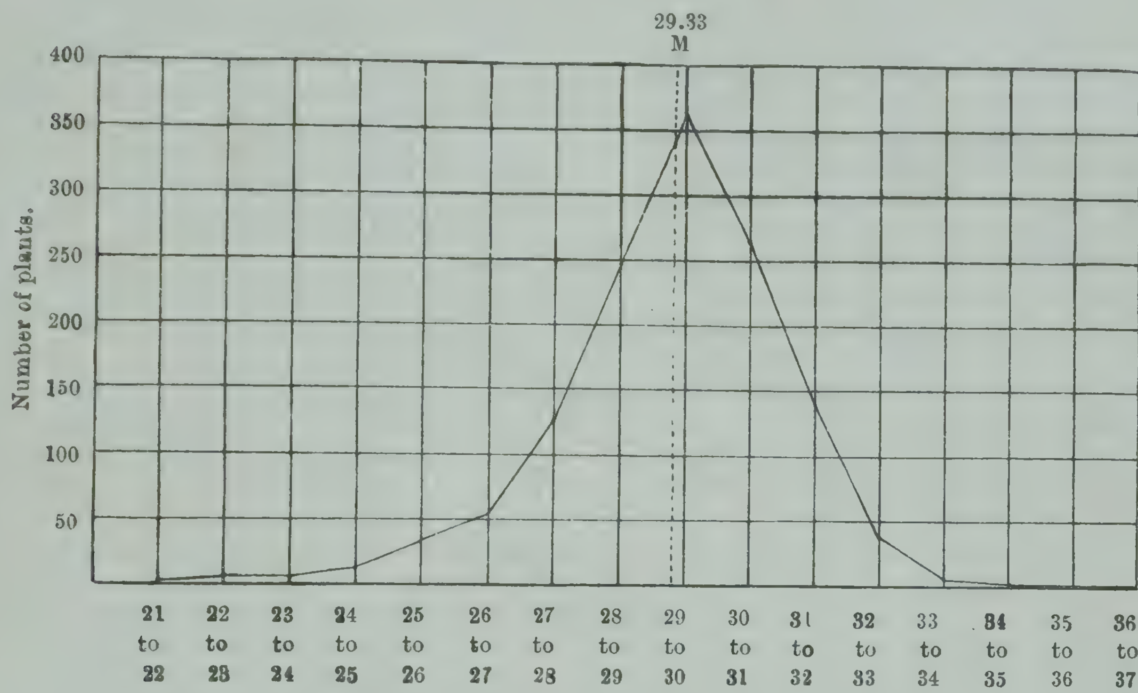
*Badly affected with 'Gwabo.'

The slight irregularity in increase in yield is due to "Gwabo," *i.e.*, the presence of empty glumes (mentioned later in this paper), the reason for which is not yet well understood. The percentage of empty grains due to this cause was taken and those numbers marked with an asterisk in the above table were all badly affected and the yield by weight thereby reduced. It was noted that those lines which contained most "Gwabo" in 1912-13 also contained most in the 1913-14 crop. This indicates a predisposition to the "disease," and if this be proved it will be necessary to take it into account in selection work.

After three years' trials (the last year repeated four times) pure line D (Field No. 1009) turned out to be one of the best races and was selected for the seed farms. Its actual yield is nearly 15 per cent. (or allowing for experimental error, about 12 per cent.) above that of ordinary hand-selected *Kalagyi*. In the case of some other varieties selected in the same way we have obtained increases in yield of 25 to 30 per cent. As, however, they still remain in the selection plots to be further proved they are not given here. The other plants graphically presented here, being little or no improvement on the original, were discarded.

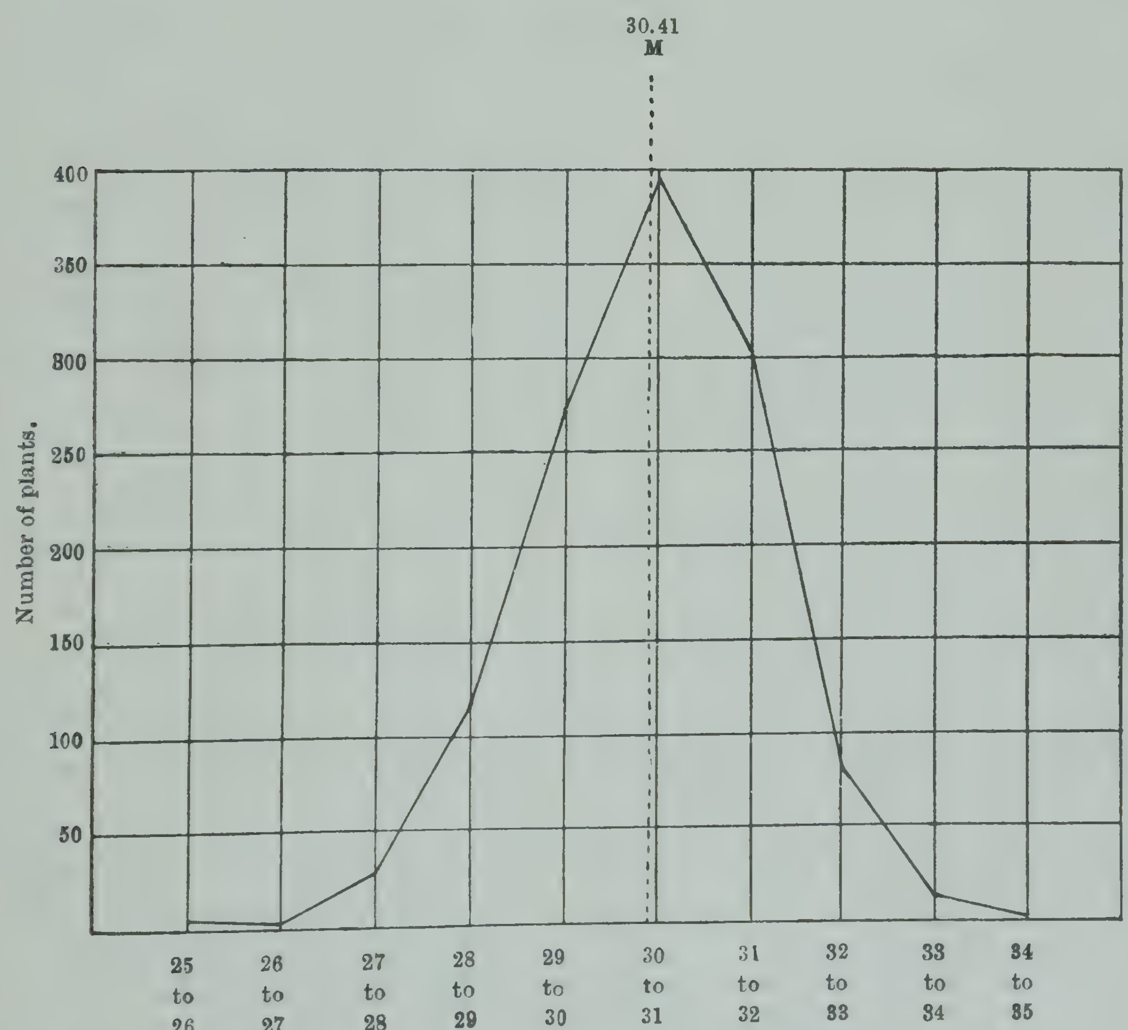
Similar graphs have resulted from the counting of seeds of other varieties and also by weighing the seed ; but in the latter case owing to the prevalence of "Gwabo" which causes empty glumes, the results were in some cases irregular. Hence the weight of grain is not always as accurate an indication of yielding capacity as the number of seeds per plant, from which, taken along with the weight of a definite number of seeds, a good idea can be obtained of the merits of a pure line at an earlier stage than can be done from variety testing in the field only.

II. *Variations in weight of grain.*—That there is a considerable variation in the weight of the grain from different plants is shown by data giving the weight of 1,000 air-dried grains of 1,293 different plants of *Kalagyi* and 1,212 different plants of *Ngaseingyi*. The plants were not selected but taken at random from even fields of ordinary grain. Diseased and obviously "light" seeds were rejected when counting.



Weight in grams of 1000 air-dried grains.

DIAGRAM V—(*Kalagyi*).



Weight in grams of 1000 air-dried grains.

DIAGRAM VI—(*Ngaseingyi*).

Diagrams V and VI show the results of *Kalagyi* and *Ngaseingyi*, respectively. The former variety has a range of variation from 21 to 37 grams with a mean weight of 29·3 grams, whilst the latter varies from 25 to 35 grams and has a mean weight of 30·4 grams. Though the grain of the two varieties is practically of the same size (from actual measurements taken *Kalagyi* appears to have a very slightly larger grain) owing to the thickness of the glumes in *Kalagyi*, *Ngasein* is the heavier grain. This is actually found to be the case in well cleaned market samples, a "basket" of the latter variety being 2 or 3 lbs. heavier than one of the former.

Plant to plant weighments were not made for the pure lines but the average weights taken from 5 separate weighings of 1,000 grains of each pure line show a considerable variation though, owing to the rigid selection carried out and to the small numbers of pure lines involved, the range of variation was not so great as in the original. The weights of 1,000 grains of the *Kalagyi* lines varied from 30·3 grams to 32·03 grams whilst those of the *Ngasein* lines varied from 30·4 grams to 32·5 grams. The fact that none of these falls below the mean of the original not only shows a part of the effect of selection, but indicates that the production of heavy-weight grain, though no doubt influenced by soil and other conditions, is hereditary and consequently that the weight of the grain can be improved by selection. The yielders of the heaviest weight of grain per acre do not by any means always produce the heaviest seed, and so far these two desirable qualities have not been found combined in the same plant to the extent that one could wish.

III. *Tillering.*—There is perhaps little need to dwell long upon the fact that tillering varies with the variety, the soil, and the treatment of the plants. In classifying the numerous varieties of paddy grown in Upper Burma several hundred samples were received and grown and under these conditions (irrigation on a second class soil) the average number of tillers produced was found to vary from four to as high as twenty-five.

Generally speaking there appears to be a relationship between the length of life of a paddy and the number of tillers produced.

The *Kaukhnyins* are generally short-lived paddies, ripening in about 140 to 160 days, and these produce comparatively few tillers; whilst the *Kaukkyans* which are generally longer-lived varieties tiller much more freely.

The following Table gives a comparison of two varieties which though producing grain of similar appearance are very dissimilar in habits. The countings are all made from single plants transplanted 1 foot apart each way.

TABLE I.

Number of Tillers.	Number of plants of	
	(1) *Kalagyi* (a 150 day variety).	(2) *Ngaseingyi* (a 170 day variety).
1	28	10
2	190	22
3	988	72
4	1,568	118
5	1,065	236
6	705	344
7	346	386
8	154	508
9	58	532
10	11	526
11	4	446
12		358
13	..	338
14	..	284
15	..	170
16	..	98
17	..	72
18	..	42
19	..	20
20	..	24
21	..	14
22	..	2
23	..	2
24	..	1
27	..	1

It will be noticed that No. 1 has its mode or highest frequency at 4 tillers and has a comparatively short range, whilst No. 2 has its mode at 9 tillers and shows a much longer range of variation. The tillering of these two varieties may then be represented graphically as in diagrams VII and VIII.

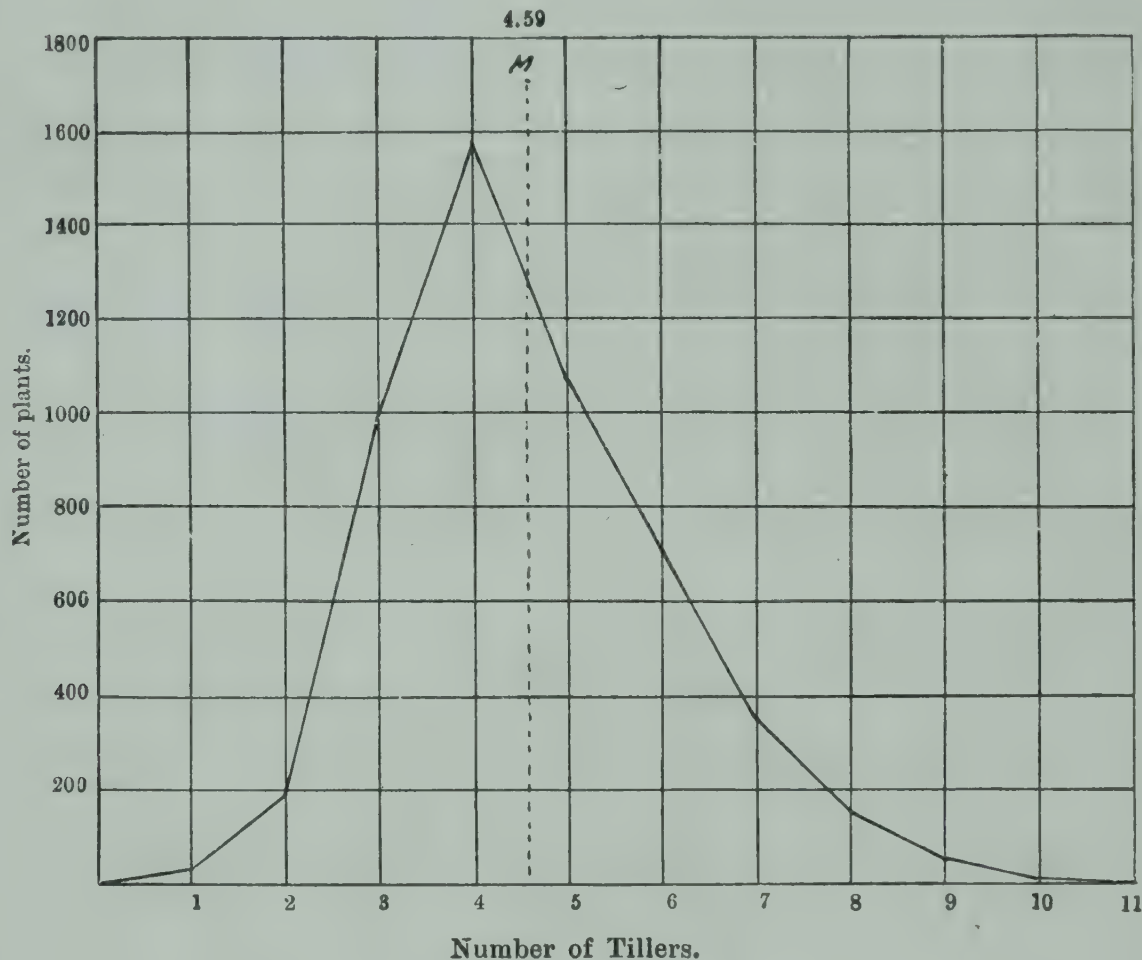


DIAGRAM VII—(1) *Kalagyi* variety.

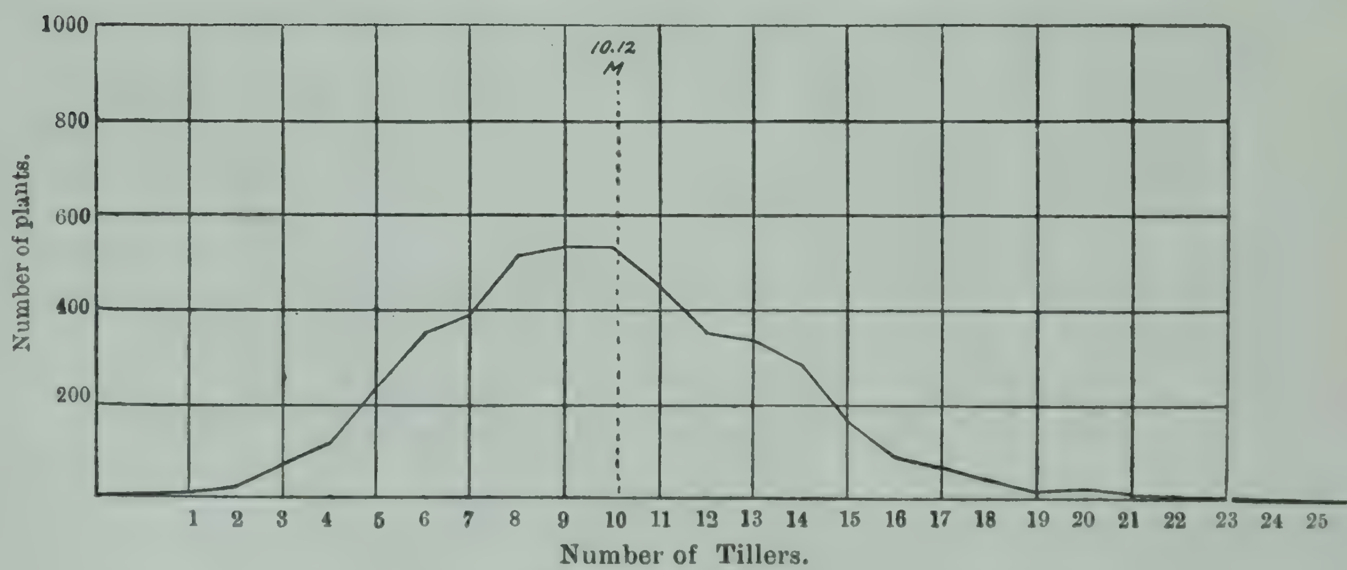


DIAGRAM VIII—(2) *Ngaseingyi* variety.

For *Kalagyi* the mean or "average type" is found to fall at 4·59 tillers per plant, whilst that of *Ngaseingyi* occurs much higher at 10·12.

Of the pure lines of *Kalagyi* only nine were counted and the mean of each was calculated. Five of these means fell slightly

below the average type of the variety and the remainder gave values above that of the type. In the case of *Ngasein* there were nine above and eight below the value of the average type. With two exceptions, however, in neither case was any striking increase in the number of tillers secured.

To ascertain whether the yield is proportional to the number of tillers observations were made on a number of pure lines of the same two varieties with the results shown in diagrams IX and X.

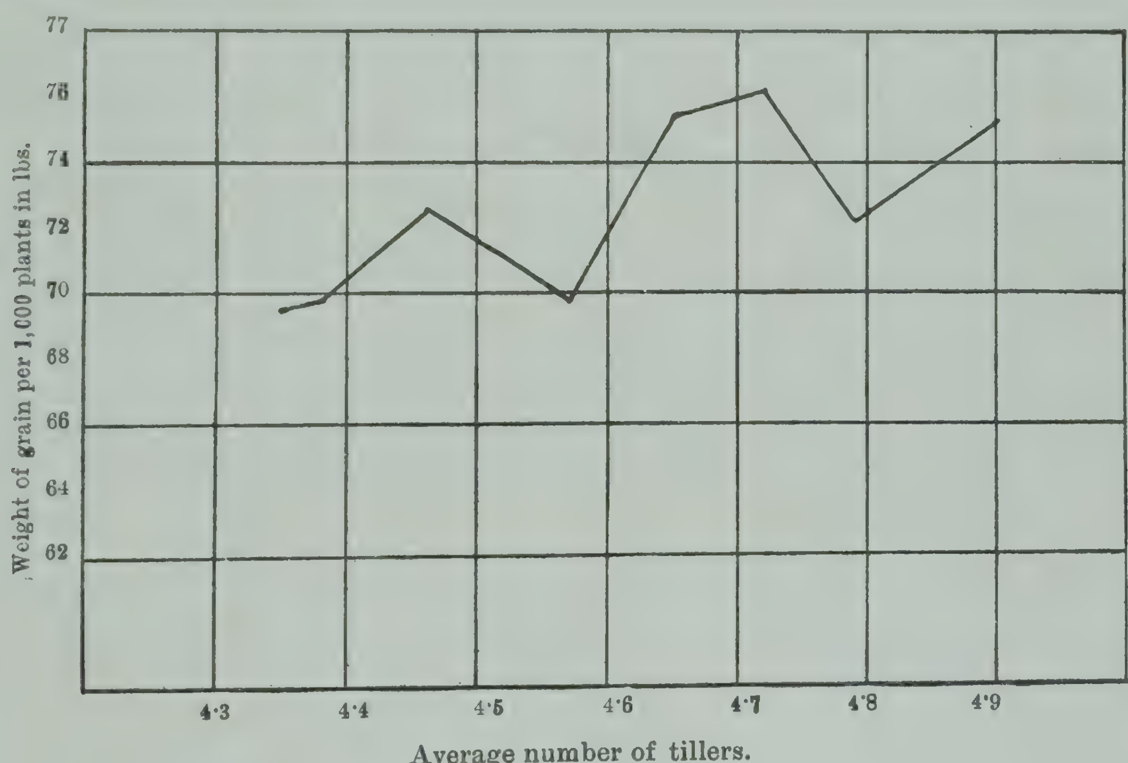


DIAGRAM IX—(*Kalagyi*).

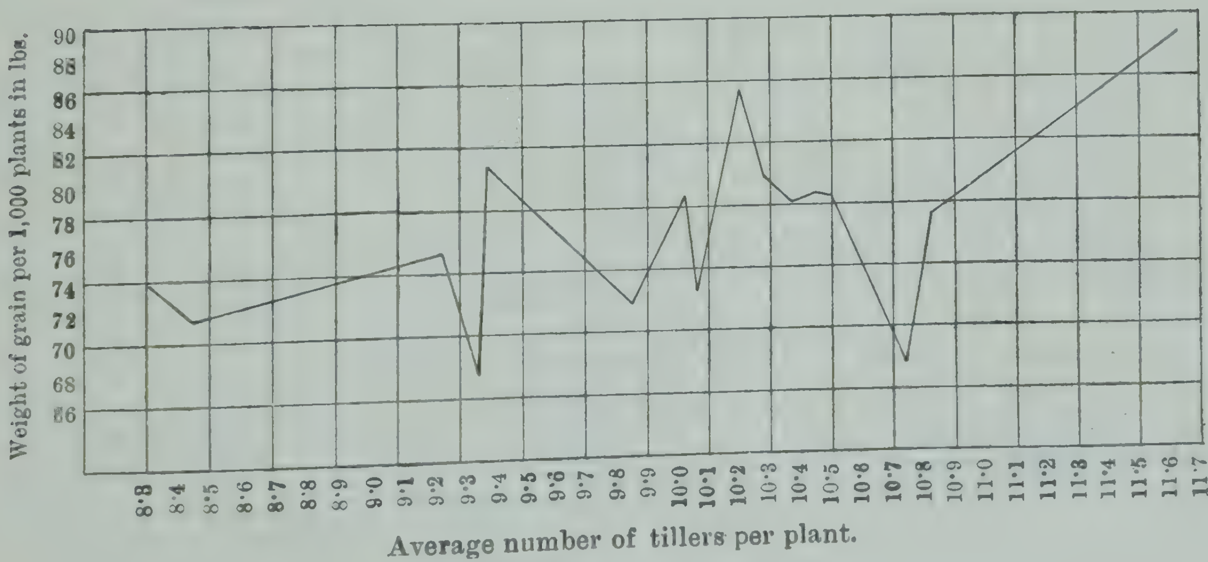


DIAGRAM X—(*Ngaseingyi*).

These graphs show that, speaking generally, as the tillers increase there is an increase in the weight of grain ; but this increase is not in *direct* proportion to the number of tillers produced by the plant. In other words as the number of tillers increases the average yield per tiller decreases. Moreover the very irregular line indicates that it by no means follows that because a plant has many shoots it is the best to select in breeding high yielding strains. One is sometimes apt to select a plant with numerous tillers without due reference to the number or weight of grains borne by each shoot. Up to the present time the highest yielding strains have been found among those whose " mean " for tillering is but a little higher than that of the original type ; whilst some of the strains with a high tillering mean have yielded by weight but comparatively poor outturns of grain—the " lines " producing high tillering averages yield comparatively small and light panicles. It is quite possible that this may be due in some degree to the restriction of the space allowed for each plant or to the soil. For a plant of many tillers to produce its maximum yield a wide or rich feeding ground must be provided.

A planting distance has been maintained at 1 foot each way for all varieties and this appears to give very good results for work of comparison, but, in the case of free-tillering strains which do not show an increase of grain in direct proportion to the number of tillers, an increase of space might result in a better outturn. If this be so the space which, theoretically, ought to be given to each plant will depend upon the hereditary mean tillering power of the strain.

A Table is given below showing roughly the Burman cultivator's idea of the distance apart of transplanting and number of seedlings in relation to soil and season. It is the result of many enquiries and the averages of many measurements taken.

No doubt the custom of reducing the distance or increasing the number of seedlings according to the condition of poverty of the soil and to lateness of transplanting has been formed by generations of experience, but at the same time one can meet many cultivators who have a very shrewd idea of the reasons for these practices.

TABLE II.

		Approximate periods of Transplanting.				
Class of Soil.		12th July to 30th July	31st July to 16th August	17th August to 30th August	31st Aug. to 15th Sept.	16th Sept. to 29th Sept.
		A.	B.	C.	D.	E.
1	First class ..	3 to 4 seedlings	3 to 4 seedlings	3 to 4 seedlings	3 to 4 seedlings	3 to 4 seedlings
		11″ apart	9″ apart	7″ apart	5″ apart	4½″ apart
2	Second class ..	3 to 4 seedlings	3 to 4 seedlings	4 to 5 seedlings	4 to 5 seedlings	4 to 5 seedlings
		9½″ apart	7″ apart	5″ apart	4½″ apart	3½″ apart
3	Third class ..	3 to 4 seedlings	4 to 5 seedlings	4 to 5 seedlings	4 to 5 seedlings	5 to 6 seedlings
		6″ apart	5″ apart	4″ apart	4″ apart	3½″ apart

That the kind or condition of the soil affects the tillering has been often observed, but the data are not sufficiently complete for reproduction. This district contains, in addition to the dark clay soil which can be readily and well puddled, several soils of a lighter and drier nature. On such soils the extent of tillering is very poor and in consequence the cultivator plants more closely. The observations on tillering on these soils have been made with three common local varieties, *viz.*, *Kalagyi*, *Ngasein*, and *Taungtaikpan*; but whether the variations are due to differences in texture, fertility, or water-supply has not been determined. The effect of increased fertility may be seen from the increase in the average number of tillers due to manuring in the table of results given below. The figures were obtained from a new manurial series started in 1913, and manured once only. Each plot has its own unmanured control plot alongside and each carried the same number of plants transplanted one foot apart each way.

TABLE III.

No.	Manurial Treatment per plot of $\frac{1}{20}$th acre.	Average number of tillers in		Difference.	Increase or Decrease.
		Manured Plots.	Control Plot.		
1	Farmyard manure 133 lbs. (30 lbs. N. per acre).	9·06	8·17	0·89	Increase.
2	Farmyard manure 221 lbs. (50 lbs. N. per acre).	8·54	8·01	0·53	Do.
3	Farmyard manure 310 lbs. (70lbs. N. per acre).	9·34	8·12	1·22	Do.
4	Cotton cake 85½ lbs. (50 lbs. N. per acre).	10·07	8·69	1·38	Do.
5	Farmyard manure 133 lbs., Superphosphate 7·3 lbs. (30 lbs. N., 20 P_2O_5 per acre).	10·73	8·62	2·11	Do
7	Farmyard manure 133 lbs., Bone Phosphate 2½ lbs. (30 lbs. N., 20 P_2O_5 per acre).	8·64	7·13	1·51	Do.
8	Bone Phosphate 2½ lbs. (20 lbs. P_2O_5 per acre).	8·18	6·83	1·35	Do.
9	Superphosphate 7·3 lbs. (20 lbs. P_2O_5 per acre).	6·22	4·54	1·68	Do.
10	Potassium Sulphate 2 lbs. (20 lbs. K_2O per acre).	5·37	5·38	0·01	Decrease.
11	Nitrate of Soda 9·2 lbs (30 lbs. N. per acre).	5·65	4·66	0·99	Increase.
12	Nitrate of Soda 9·2 lbs. (30 lbs. N. per acre).	7·34	6·28	1·06	Do.
13	Ammonium Sulphate 7·6 lbs. (30 lbs. N. per acre).	6·95	5·70	1·25	Do.
14	Nitrolime 8·2 lbs. (30 lbs. N. per acre).	7·23	5·31	1·92	Do.
15	Slaked lime 100 lbs. (2,000 lbs. per acre).	5·11	5·65	0·54	Decrease.
16	Bone Sulphate 7·6 lbs., Superphosphate 7·3 lbs., Potassium Sulphate 2 lbs. (30 lbs. N., 20 lbs. P_2O_5, 20 lbs. K_2O per acre).	8·55	5·13	3·42	Increase.
17	Burnt paddy husk 600 lbs.	6·48	6·39	0·09	Do.
18	*Nil*	4·61	4·64	0·03	

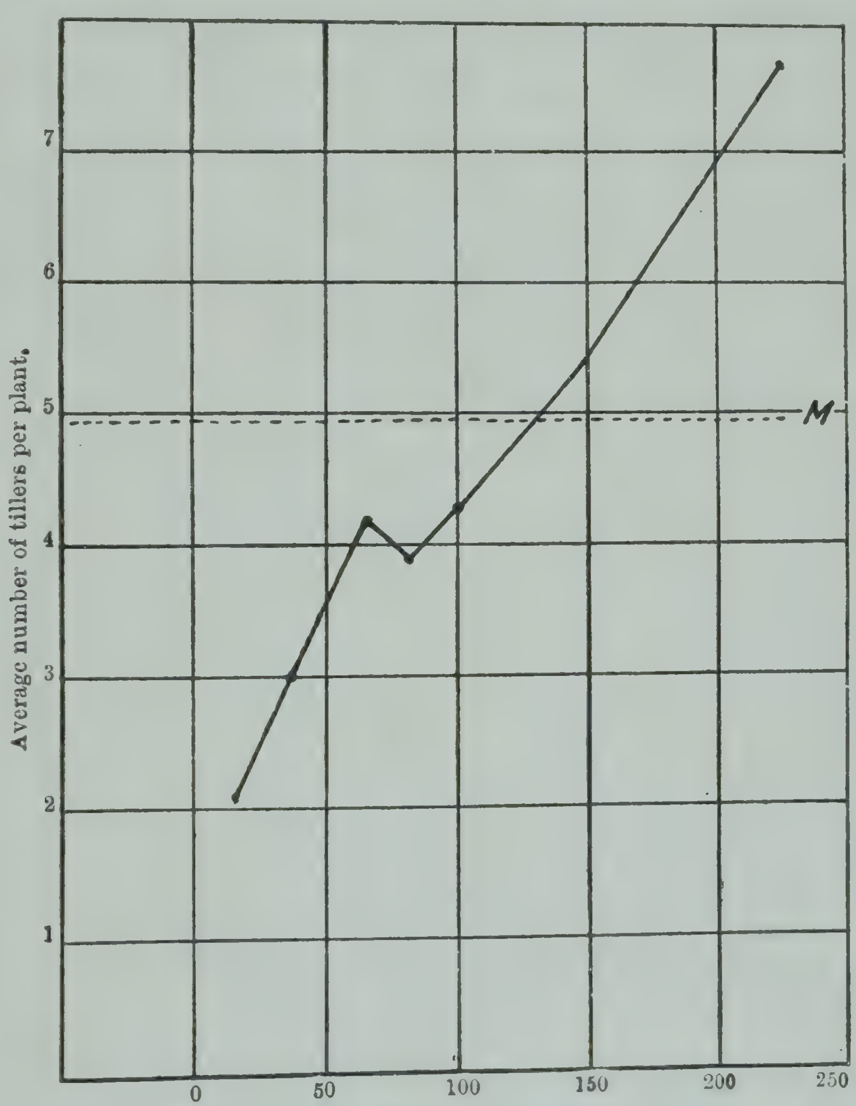
Organic manures and some of the chemical manures, *e.g.*, ammonium sulphate, appear to have a marked effect upon the tillering.

The number of tillers produced per plant varies (up to a certain point) directly according to the space allowed in transplanting. From a large number of single-plant transplanting experimental results, the following averages have been calculated for one variety :—

TABLE IV.

Distance apart of Transplanting.	Space per plant in square inches.	Average number of Tillers per plant.	Average weight of grain per 100 plants in Ozs.
4″ × 4″	16	2·1	10·9
6″ × 6″	36	3·0	10·7
8″ × 8″	64	4·2	29·1
9″ × 9″	81	3·9	29·4
10″ × 10″	100	4·3	32·3
12″ × 12″	144	5·4	38·7
15″ × 15″	225	7·7	67·9
Unlimited space	...	Up to 27	..

Diagram XI represents these results in a graphic form.



Area occupied by each plant in square inches.

DIAGRAM XI.

Similar results have been obtained for some other varieties, but it is unnecessary to reproduce more of them here.

In group planting it was found that though the best yields were obtained by planting "doubles," the average number of shoots arising from each pit varied as the number of transplants, but not in direct proportion.

Number of plants per group or pit.	Average number of Tillers.
1	3·30
2	3·75
3	5·30
4	5·60

This result is not in accord with those reported from Madras Presidency and as it was obtained from a comparatively small number of countings further data will be collected.

As opposed to the planting of a number of seedlings in one pit it was found that a well grown plant can, after it has produced tillers, be divided a number of times and that division and retransplanting appear to stimulate tillering.

On Cross-fertilization and Heredity.

The results given below have been obtained only in connection with the line-breeding method of plant improvement begun in 1910, and the materials made use of in preparing this note were originally gathered as subsidiary observations in connection with the more important work on hand. Previous to that time (1910), it had been repeatedly proved to the writer that plants producing red grains frequently make their appearance in crops of white-grained varieties, considerably reducing the value of the produce and causing a great deal of trouble to the cultivators; many of whom, in their own way, frequently make repeated efforts to get rid of such undesirable plants. The method not infrequently adopted is hand-selection of sufficient good heads for seed purposes; but, while this no doubt tended to improve the produce, it seldom had the desired effect in the succeeding crop of eliminating red grain, the reappearance of which is accounted for by the cultivators in various ways. Whilst most of their theories are of a superstitious nature pertaining to "Nats" or other supernatural beliefs, the writer has frequently

been told that the cause is cross-fertilization regarding which many observant Burmans are by no means ignorant.

Among a number of single plant selections of *Ngasein* paddy were found four plants, which, although in external appearance exactly like ordinary *Ngasein*, produced all red grain. In 1911 the produce of each of these plants was planted in rows of single plants 1 foot apart. In two plots, the produce of plants labelled B and X there were found to be four different kinds of plants as shown below ; but in the other plots the plants all came true to the type sown, so far as the characters under observation were concerned.

TABLE V.

Result of Plots B and X.

Description of Plant.	Number of Plants.
(*a*) White glumes, red grain	239
(*b*) Red glumes, red grain	75
(*c*) White glumes, white grain	73
(*d*) Red glumes, white grain	27
	414

This gives 314 red-grained plants and 100 white-grained plants ; also 312 white-glumed plants and 102 red-glumed ones. The proportions of these are 3·14 : 1 and 3·1 : 1, respectively.

The conclusions drawn from these figures have since been to a large extent proved by other writers.[1]

(1) That plants B and X were natural hybrids or heterozygous plants of some previous natural cross-fertilization.

(2) That whiteness and redness of glumes act as a pair of simple Mendelian characters, the former being dominant.

(3) That whiteness and redness of grain also act as a pair of simple Mendelian characters, redness being dominant.

(a) Hector, G. P. *loc. cit.*
(b) McKerral, A. *loc. cit.*

The recessive colour of the glumes was a deep rusty red whilst the dominant colour was a dull white or very pale yellow.

These pairs of characters were by no means the only variants, but they were the only ones for which numerical observations were taken.

In the following year the produce of each of the different classes was again sown to see what happened. A measure of about 200 seeds from each plant was sown in nurseries separately and thinly and the transplants were planted singly at no definite but at a good distance apart, so as to facilitate examination of each plant. Unfortunately it was not possible to deal with all the seed of each plant or to take account of any characters other than those observed on the previous occasion.

From (*a*) (see Table V above), that is the produce of plants having, like the original hybrid, white glumes and red grain there were grown 239 plots each from the seed of a single plant. Every plant was examined with the result given in the Table below.

TABLE VI.

Result of (a) plots.

No.	Description of plants.	Number of plots.	Number of plants having :—			
			White Glumes.		Red Glumes.	
			Red grain.	White grain.	Red grain.	White grain.
1	2	3	4	5	6	7
I	All plants with white glumes and red grain	26	2,198	..	..	..
II	All plants with white glumes but grain of some plants red and of some white	55	3,124	1,010	..	..
III	All plants with red grain but glumes of some plants white and of some red	57	2,801	..	932	..
IV	Plots a complete mixture as obtained in the previous year ..	101	5,236	1,673	1,728	577
	TOTAL ..	239	13,359	2,683	2,660	577

The significance of the above results is easy to see. In No. I the parent plants were all homozygous for both characters. In No. II they were homozygous for glume colour, but heterozygous for colour of grain, whilst in No. III they were homozygous in respect of grain colour, but heterozygous for colour of glumes. In No. IV the plants were heterozygous for both characters.

The numbers obtained may now be examined. As already shown (Table V) in the F_2 generation, the proportion of white-glumed to red-glumed plants was approximately 3 : 1, and if splitting is taking place in Mendelian proportions, one of the three white-glumed plants will be homozygous. Similarly in the 3 : 1 proportion of red-grained to white-grained plants, one of the three will be homozygous and the other two heterozygous for that character. Hence, among the 239 plants of (*a*) there should be one-third (or 239/3) homozygous white-glumed, and the same number of homozygous red-grained plants, but the probability of these characters being combined in the same plant is only $\frac{1}{3}$ of $\frac{1}{3}$ *i.e.*, 1/9.

A glance at the following diagram, where W stands for whiteness of glume, w for absence of this character, R for redness of grain, and r for absence of redness, will make this clear.

Whiteness of glumes.

	WW RR	WW Rr	WW Rr
Redness of grains ..	Ww RR	Ww Rr	Ww Rr
	Ww RR	Ww Rr	Ww Rr

WW and RR are combined in only one plant out of nine; though there are WW and RR each in two other plants, the remaining four plants being heterozygous for both characters. The actual proportion of plots obtained (see Table VI) was 1 : 2·11 : 2·26 : 3·81 (*i.e.*, 1 W W R R to 2·11 W W Rr to 2·26 Ww R R to 3·81 Ww Rr); that is almost as might be expected 1 : 2 : 2 : 4. In considering these figures one must bear in mind the small number of plots involved.

Now in reference to the numbers of plants in the plots No. II, the proportion of red to white-grained plants is 3·09 : 1 and the proportion of white-glumed to red-glumed plants is almost exactly 3 : 1. In plots No. IV the proportions of white-glumed to red-glumed plants (6,909 to 2,305) and red-grained to white-grained plants (6,964 to 2,250) are respectively 2·99 : 1 and 3·09 : 1.

There now remain to be considered the results obtained by sowing (*b*), (*c*), and (*d*) of Table V, but as these are much more simple than those of (*a*) they will be included in one statement. As in the case of (*a*), a quantity of seed of each plant was sown and transplanted separately; and every successful plant of the produce was examined for the characters under observation.

TABLE VII.

Plots marked (Table V).	Description of Parent Plants.	Total Plots.	Number of plots pure, *i.e.*, producing only plants like parent (*b*).	Plants in pure plots.	Impure plots giving mixed produce.	Number of plants in impure plots having			
						White glumes.		Red glumes.	
						White grain.	Red grain.	White grain.	Red grain.
(*b*)	Red glumes, red grain ..	75	26 plots	4847	49	..	5*	1827	5660
(*c*)	White glumes, white grain .	73	27 ,,	4223	46	6586	16*	2227	..
(*d*)	Red glumes, white grain .	27	27 ,,	4816	..	..	..	..	3*

The numbers in the above table marked with an asterisk are not easy to explain. The plants occurred singly, or, in not more than two or three, in any plot of 100 to 200 plants and the only explanation that can be given is that they are accidental mixtures possibly from dropped seed of the previous year's crop.

From plants marked (*b*) were obtained 26 plots which are pure for both characters and 49 the parent plants of which were homozygous for red-glume colour but heterozygous for grain colour, the proportion of red to white-grained plants being 3·09 : 1.

From (*c*) we obtained 27 plots which may be regarded as pure for both characters and 46 which proved to be homozygous for grain colour, which is white, but heterozygous for colour of glume. The proportion of white-glumed plants to red-glumed plants, in the latter plots, is 2·95 : 1.

From (*d*) we obtained nothing but plants having red glumes and white grain. Hence the parent plants were pure for both of these two characters.

Apart from glume and grain colour a great variety of forms were obtained especially as regards size and shape of grain, but, as already explained, numerical calculations could not be undertaken. Specimens of some of these forms have, however, been retained for educational purposes and at the same time a few apparently exceptionally prolific plants derived from these hybrids have been selected for field trial purposes.

In another and independent experiment carried out in 1913 an Assistant obtained the following results from 11 plants of the F_2 generation :—

TABLE VIII.

Plant No.	Plants with red grain.	Plants with white grain.
1	28	60
2	37	76
3	26	66
4	20	69
5	17	91
6	33	64
7	19	75
8	33	80
9	18	81
10	21	77
11	16	84
	268	823

The proportion bears out the results obtained above and those obtained by the other writers already mentioned.

Pollination, Natural Cross-fertilization, etc.

In the *Monthly Bulletin of Agricultural Intelligence and Plant Diseases*, Rome, for June 1913, page 894, there is given a summary

of the report of observations and experiments conducted by Rudolfo Farneti, in Atti dell' Istituto Botanico dell' Universita di Pavia. In this summary it is stated "that the pales of rice never open, before, during, or after the dehiscence of the anthers. Consequently the natural production of hybrids is impossible even as a chance occurrence." However true this may be for Southern Europe, it is certainly incorrect as applied to Burma. In the dry districts of Upper Burma hybrids are quite common among the numerous "rogues" to be found in nearly every field of ordinary paddy, and Mr. McKerral has shown that they are not difficult to find in the wet zone of Lower Burma. Of the red "rogues" selected from a field of white paddy 22 per cent. were found by him to split up—proving that they were heterozygous. It is difficult to see how this condition of things could have arisen except by mixtures or close growing of red and white-grained plants and subsequent natural cross-fertilization.

With the assistance of Mr. Sawyer, Assistant Botanist, the writer has from year to year examined a very large number of plants of many varieties of *Kaukgyi* at the time of flowering and has found that the following observations hold good in every case :—

(*i*) As the heads of paddy emerge from the sheath the flowers mature from above downwards, before, or when very little spreading of the panicle has taken place. The stamens emerge daily generally from segment of the head which has just come out of the sheath and the head ripens the whole of its flowers in 3 or 4 stages on successive mornings.

(*ii*) The glumes open, the stamens hang out, and the feathery stigmas protrude once only and for a short time in the early morning —usually between 7 and 10 A.M. Dewy mornings appear to be most favourable, and "flowering" will then be at its maximum height about 8 to 9 A.M. As the dew gradually disappears the flowers will be found to be opening rapidly but, as soon as the day begins to get very bright, dry, and warm, no more glumes open and those already opened close up again—the stamens by this time being dried and shrivelled up.

(*iii*) The angle formed by the two edges of the glumes when the flowers are fully open is about 25 to 30 degrees, but the stamens have often emerged before the flower is fully open.

(*iv*) Pollination takes place before the glumes open, or at the moment of opening—seldom afterwards. At the moment they emerge from the glumes the anthers are found to be already open at the lower end, and with the aid of a microscope, pollen grains can generally be found on the stigmas.

From a few flowers allowed to open naturally as the anthers were on the point of emerging (or as far as possible just before they emerged) they were nipped off and the flowers covered up. The fruits of all these that were uninjured by the process developed normally. On the other hand, of those which were opened artificially and the anthers removed before flower was ready to open and afterwards left without covering, about 5 per cent. developed normal fruits (actually 11 out of 208). This may, however, have been due, partly at least, to the great difficulty experienced in opening unripe flowers without injuring them.

The stiffness of the glumes and the manner in which they "hook" together make artificial cross-fertilization difficult. It is not easy to open the flower without damaging the glumes so that one or other of them shrivels up, but a little success was attained by first running a fine needle between the two glumes on each side so as to unhook them and then carefully opening the glumes but a short distance to remove the stamens.

One other point in connection with fertilization and the prevalence of "Gwabo" may be worth mentioning here.

"Gwabo" is the Burmese name given to that condition of paddy which causes empty husk without any grain enclosed. In some parts of Burma and in some seasons "Gwabo" is very prevalent —the writer has seen samples threshed with twelve to fifteen per cent. of empty husk. Although it is known that whole heads of unfilled grain may be the result of boring grubs (*Schoenobius bipunctifer*, etc.) which are fairly common in some parts and that, as shown

by Dr. Butler,[1] the fungus *Sclerotium Oryzœ* may be the cause of considerable losses yet these are not what is generally referred to as " Gwabo " nor can they be made to account for more than a small portion of the damage, which amounts to many lakhs of rupees annually. The presence of the borer grub is easily seen and the work of the fungus is not difficult to identify. The real " Gwabo " as mentioned here is that condition where the sterile grains are not found in whole heads or even in masses on one head but scattered throughout the panicle among the sound grains. The grains near the rachis are more generally affected than those on the ends of the branches. The ears are not discoloured ; and there is no late tillering or development of green sterile shoots or discoloration of lower internodes to indicate the presence of the fungus. The husk is completely empty (except for the shrivelled stamens and ovary). It contains no badly developed grain as is sometimes the case after the work of the insect and the fungus—there does not appear to have been any attempt at development.

Since Dr. Butler's investigation took place in 1912 the present writer has tried unsuccessfully in several ways to find out the cause of this condition which results in such an enormous loss to the country and is rapidly being converted to the idea that it is caused by some external physical agency. It appears to be quite possible that conditions of climate and atmospheric moisture may have some effect upon the fertilization of the ovules. Many intelligent Burman cultivators maintain that heavy rainfall at the time of flowering is the cause of this sterility and consequently after a season which is very wet at the time paddy is flowering " Gwabo" is prevalent. This is in accord with Hector's[2] statement that " If the weather is wet and rainy at the time when the flowers should normally open..........., they may not open at all or, if they do, they often do not close again and a large percentage of such flowers set no grain." Other cultivators state that excessive

[1] " Diseases of Rice," *Bulletin No. 34, Agricultural Research Institute, Pusa,* pages 34-36.

[2] " Notes on Pollination and Cross-fertilization in the common Rice plant, *Oryza Sativa,* Linn." *Mem. of the Dept. of Agr. in India, Bot. Series,* Volume VI, No. 1, page 4.

irrigation has the same effect, whilst still others have similar theories connected with the wind.

No evidence can at present be found indicating that there is a greater proportion of empty husks in those varieties flowering here during the rains than in those flowering during the dry weather. In fact observations point in the other direction, *viz.*, that the *Kaukgyi* crop—flowering in November-December—suffers the greatest proportion of loss. If, as is generally believed, climatic conditions do modify pollination or its effects the above appears to indicate that the varieties which habitually flower during the rainy season are in some way adapted for this purpose; but the *Kaukgyi* varieties, not being so adapted, when a wet spell occurs at the time of flowering, are unable to effect fertilization of all the flowers. If such be the case or if weather conditions are responsible the chances of finding a remedy and so reducing the enormous losses which occur in the main crop are very remote. The investigation of "Gwabo" is still being continued.

SUGAR PRODUCTION IN THE UNITED PROVINCES, FROM AN ENGINEER'S POINT OF VIEW.

BY

WILLIAM HULME,

Sugar Engineer Expert.

It will be viewed with some concern by those responsible for the development of the agricultural resources of India that the importation of sugar is steadily increasing. This will readily be seen by comparing the following import statistics obtained from the India Office, London:—

		1903-4.	1912-13.	1913-14.
Cwts.	...	6,333,843	15,443,033	17,937,390
£	...	3,957,183	9,519,172	9,971,200

shewing an increase in ten years of 11,603,547 cwts. of the value of £6,014,017, the increase for last year over the previous year alone being 2,494,357 cwts.

Of the sugar imported into India three-fourths comes from Java, and the question naturally arises why this should be so. The reasons for this commanding position of Java in the sugar-world probably are :—

(1) Efficiency of the staffs controlling the factories.

(2) The installation of the best machinery in the factories.

(3) Intensive cultivation.

(4) Climatic conditions and the geographical position of the island.

It will be admitted that the first three factors are applicable to any sugar-producing country, but the fourth requisite enforces the fact that the *climatic conditions* of Java are more suitable than

those of the United Provinces for the cultivation of the sugar-cane, and this certainly gives Java an advantage, the exact extent of which cannot at present be accurately estimated. But on the other hand the *geographical position* of the United Provinces has some compensating advantages. It is said that it costs Java Rs. 37-8 per ton to get her sugar into the United Provinces. If this is so, it is a considerable tax on Java sugar brought to the United Provinces and other markets north and west of this sugar-producing region. It is thus quite possible that the advantages obtained from the climatic conditions of Java over the United Provinces are cancelled by the exorbitant cost of transport.

It will be interesting to watch the development of the new sugar factory which has been recently erected in the Gorakhpur district. It is said to be the intention of the proprietors to raise the efficiency of the factory to the same standard as that in vogue in Java factories. If this is done, and a sufficient supply of good fresh cane is maintained during the season, satisfactory results may be confidently anticipated.

It is unfortunate that the cultivation of cane in India is done on scattered areas, as this causes delays and difficulties to factories capable of crushing from 8,000 to 12,000 maunds of cane per diem. It is well-known that rapid deterioration of the sugar-cane occurs after cutting, hence if there is any delay between cutting and crushing much loss is caused to the factory ; it is therefore imperative to exercise skilful and strenuous supervision in regulating the cutting of the cane at the proper time and ensuring delivery with the least possible delay.

At present the factory owners are in most cases compelled to buy the cane in small lots from numerous cultivators, who are eager to get the matured cane off their land in order to prepare it for other crops, and in their eagerness frequently attempt to deliver more cane per day than the quantity arranged for. The result of this procedure is that the factory owners must either refuse to take the cane, which would be disastrous to the cultivator or crush stale cane at a loss to themselves.

The duration of the "campaign" is of great importance to the factory owners, and where practicable it would be advantageous for them to acquire sufficient land adjacent to each factory to grow about one-third of the cane required by that particular factory during a season. This would enable them to cultivate both early and late-ripening varieties of cane, so as to extend the season to the utmost. An extension of twenty days would increase the season's output twenty per cent., without appreciably increasing the establishment charges. Other advantages would also accrue if high-class cultivation were adopted on the factory plantation. To mention only one, the local cultivator would be induced to improve his cultivation, and thereby get, per acre, more cane of richer and better quality.

The quantity produced per acre is very important in these days of keen competition, and has become a factor which cannot be neglected. The selection of suitable land and its irrigation are of the highest importance, and in any scheme for the production of sugar on a large scale and to compete with foreign markets they must be carefully considered.

The Agricultural Department is working on the selection of varieties and the cultivation of sugar-cane in various districts, and good results may be expected in due course.

For the efficient control of a modern factory it is necessary to employ a highly technical staff of trained men, comprising a manager with a general knowledge of the business, a chief engineer with an assistant, both of whom must have been trained in sugar machinery, a chemist who has specialized in the chemistry of sugar and sugar-cane, and trained sugar-boilers or pan-men. As the salaries of such a staff would be considerable items in the establishment charges, and the depreciation on the expensive machinery is necessarily high, and in view of the fact that the campaign lasts only 100 days, it is essential that the factory should work continuously during the whole of that period. Therefore the staff must be energetic and resourceful, and well able to cope with any difficulties that may arise.

A factory dealing with 12,000 maunds of cane per day would pay better than one crushing 8,000 maunds. There are many factories in other countries crushing 15,000 maunds per day, but in the United Provinces it would be difficult to centralize so much cane unless the owners acquired a considerable area of land near the factory and adopted modern appliances for the quick conveyance of the cane from the fields to the factory.

The smaller the factory the more difficult it becomes to make it pay. The same skilled staff is necessary for a small modern factory as for a large one, and as the duration of the campaign is only 100 days, the comparatively small turn-over is heavily taxed to pay the wages of the permanent skilled staff (who are practically idle for 265 days in the year), the interest on capital, and a fair amount for depreciation.

It is suggested that if some other business were combined with the smaller-sized factories so as to utilize some of the machinery and the idle skilled staff, then the smaller-sized modern sugar-factories crushing, say, about 1,500 maunds of cane per day would have a better chance of success.

In looking around for a suitable adjunct to a small sugar-factory it would appear that as plenty of oil-seeds are grown locally, a seed-crushing and oil-extracting plant might be adopted with some prospect of success. There appears to be a fair market for oil of most kinds locally, and the meal from the seeds could be mixed with the molasses from the sugar-factory, compressed into cake or cakettes, and sold for feeding horses and cattle when ordinary fodder is scarce.

A huge business is done in England and France in feeding stuffs, the seeds for which are carried from India and other countries and the molasses from America and the West Indies, and judging by the rapid growth of the business in recent years it is reasonable to assume that considerable profits are made. In the United Provinces the materials (oil-seeds and molasses) are on the spot, and the nucleus of a seed-crushing plant, consisting of the existing boilers and engines, pumps, tanks, water-supply, offices and an intelligent staff, is already installed in the sugar-factory. The

processes of seed-crushing, oil-extracting, and even oil-refining are simple ; and a little training would suffice to make the staff efficient, whilst the additional cost of a seed-crushing and oil-refining plant when compared with the cost of a sugar factory is very low.

It is suggested to start the seed-crushing plant when the sugar season is over and to run it for about 200 days. This arrangement would afford the staff a rest of about two months in the year, and during that time the boilers and engines could be inspected and, if necessary, repaired.

The seeds available for crushing in the United Provinces are rape, linseed, gingelly, castor, ground-nuts, mustard, and cotton, some of which are very rich in oil.

The market for oil is assured, and there is also a fair market for oil-cake and other feeding-stuff.

It is probable that a seed-crushing and oil-extracting plant will be installed by the proprietors of a certain modern sugar factory in the United Provinces in the near future. If it proves to be a success there will be better prospects for the success of small modern sugar factories.

The improvement of the indigenous methods of sugar production in the United Provinces has been under consideration for some time. At first sight this would appear to be an easy thing to do, but there are obstacles in the way. In modern factories there are multiple-mills weighing 700 tons, whilst in India most of the crushing is done by bullock-mill that a strong man can lift. These bullock-mills are usually fitted with three rollers, two of 10″ by 8″, and one smaller for regulating the feeding of the mill. They are arranged to work in a vertical position, at a peripheral speed of about six feet per minute, and the average extraction of sucrose by such mills is about 50 per cent., as against about 90 per cent., in a modern multiple-mill.

Crushing sugar-cane is no longer work for bullocks, and as long as it continues so will the importation of sugar increase.

As nearly all the cane in India is crushed by bullock-mills, it is impossible to expect any increase in extraction from that source.

The bullocks at the commencement of the crushing-season are generally worn and weary, and very often the mills are "slacked off" to enable the weak bullock to rotate the mills which naturally reduces the extraction and causes much loss to the cultivator, who is usually too poor to buy stronger bullocks even if such were available.

To improve the extraction more power is required, the cultivator has not got it, and cannot get it.

Any scheme to improve the indigenous methods of the production of sugar must include power-driven mills, which are costly and beyond the purchasing power of the ordinary cultivator. It is possible that a number of cultivators in co-operation with the *khandsaris* could purchase a power-mill, and the question arises as to what kind of motive power would be the most suitable. Steam-power appears to be the best because the megass, supplemented by a little fuel, could be used for generating steam, also the exhaust steam for heating the juice, and the waste heat from the boiler for evaporating.

Of course the owners would have to conform to the Boiler and Prime-movers' Acts (these Acts may keep many enterprising people from taking up mechanical power), and employ a certificated man.

What kind of a power-mill would be the most suitable?

A good single three-roller mill at its best, with United Provinces cane, would, at a speed of 18 feet (peripheral), extract about 65 per cent., a double-mill (six rollers) would extract about 75 per cent., and a triple-mill with crusher would extract about 90 per cent. Therefore if the suggested co-operative company could raise the money, the triple-mill would give the best results; but if the money could not be raised the double-mill could be reduced in speed, and an extraction of about 80 per cent. obtained.

Then as to the size of the mill. 270 maunds of cane per day (about 80 acres of cane in 100 days) would be small enough to warrant the capital outlay, and a reasonable turn-over to meet depreciation and the expense of a skilled man (Indian).

It is not to be expected that this small factory would be able to make sugar to compete with foreign sugar ; but it would supply sugar or *gur*, such as is now made by country factories for consumption by orthodox Indians, and for which higher prices are paid (although, most of it is very impure) than for factory-made sugar.

The objects of such a factory would be to reduce the loss in extraction at present made by the bullock-mill, and the losses due to inversion and caramelization ; the heat for boiling purposes would be under control, and the losses due to over-heating, which are considerable at present, would be reduced to a minimum.

It would also greatly help the industry if the *khandsaris* undertook the crushing of the cane by steam-power and relieved the cultivators from that work. At present in Bareilly District they buy the juice from the cultivators and boil it into *rab* which is afterwards centrifuged, the molasses taken off is boiled again and a second sugar is made. Then the sugar is put through a grinding and bleaching process which is certainly ingenious, but at the same time very objectionable, for it is taken outside into the sun on to a square patch of ground which has been levelled and covered in some instances with a layer of concrete, and sometimes with a layer of cow-dung which is beaten down to form a hard surface. Strips of thin cotton-cloth are laid down, and the sugar is placed on the cloths in long and low narrow ridges, from about 12″ to 15″ at the base and 6″ or 7″ high. Trained men stand barefooted on the top of each ridge and by a peculiar twist and side movement of the ankle and foot gently grind the sugar, moving along the ridges in this fashion from end to end many times. Another coolie follows turning over the sugar and casting it up from the sides to the top of the ridges. The work of the foot-grinder is laborious, and must be done in the glare of the sun on account of the bleaching action of its rays. Consequently the men perspire, the sugar sticks to their feet, and is from time to time scraped off and carefully returned to the ridges.

This sugar fetches very high prices, very often Rs. 3 per maund, more than is paid for high-class factory-sugar of high purity. It

is difficult to find out whether this fancy price is paid for the imparted flavour, or on account of prejudice against modern factory-made sugar ; probably it is the latter.

It is gratifying to note that there is evidence of this prejudice gradually weakening. The sugar made at the modern factory at Pilibhit owned by Raja Lalta Prasad and Sahu Hari Prasad is nearly all sold to orthodox Hindus. The Raja and his brother invite all and sundry to visit their factory, so that they may see that there is nothing used in the process which would be objectionable to the most orthodox.

Probably one cause of the increasing importation of foreign sugar into India is that the sweetmeat-maker finds it more profitable to mix foreign with Indian sugar. When he clarifies Indian sugar some of the weight is lost in taking off the scums from the impure sugar, as well as the cost of the re-agents that he uses (tartaric acid, etc.). Most of the foreign sugar is much purer than the Indian sugar and is cheaper. He cannot use all foreign sugar because the public demands the molasses flavour present in the Indian sugar, therefore he mixes the Indian and foreign sugars and produces better-looking sweets.

It is highly probable that there will be a large demand for *gur* for many years to come, and it is recognised by the Government of the United Provinces that something might be done to improve the general conditions of *gur*-making, and in some degree reduce the losses due (1) to low extraction of juice from the cane, (2) to overheating the juice, causing caramelization, and (3) to inversion caused by acidity of the juice. To this end a series of experiments will be carried out on a Government Farm near Bareilly.

A small but powerful multiple-mill has been erected near Bareilly, by means of which, it is expected, useful data may be obtained regarding the advantages of maceration. When the extraction of juice from the cane is very high, sap juices are expressed, and these require special treatment necessitating the employment of a chemist. The salary of a chemist would be a burden upon a very small factory, and with this in view experiments will be made to find out the limit of extraction in order not to express

the sap juices, and to find out some simpler way of treating the juices than is practised to-day in modern factories.

It is a long stride from the country bullock-mill to the multiple power-mill, but the adoption of the latter seems to be the only way to stop the enormous losses which cannot be avoided while the small country-mill is rotated by worn and weary bullocks.

By the adoption of multiple-mills the extraction would be improved about 30 per cent. This increase of thirty per cent. on the sugar (which is said to be 3,000,000 tons), produced by the country methods in India, would amount to 900,000 tons at £10 per ton; that is a saving of £9,000,000 or Rs. 13,50,00,000. Some saving could be looked for also in connection with the treatment of the juices.

We are bound to recognize the fact that climatic conditions are not as favourable to the growth of sugarcane in the United Provinces as they are in Java, our principal competitor; and this fact in itself is a strong reason why the losses in extraction and manufacture should be brought down to a minimum.

The writer hopes the forthcoming experiments will help in the arrangement and design of a small plant suitable for adoption by *khandsaris* and others who are already interested in sugar production, and that the efforts being made by the Agricultural Departments in the selection of varieties of sugarcane and improvements in cultivation will be rewarded with the success they deserve.

CATTLE FEEDING EXPERIMENTS IN DENMARK.

BY

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At the last two meetings of the Board of Agriculture in India the question of the investigation of the relative feeding values of Indian cattle foods has been raised. At the last meeting, December, 1913, the conclusion was arrived at that "The Board considers that a scientific investigation could only be carried out by a special staff with special equipment such as could not at present be justified by the comparative importance of the results likely to be obtained."

This would seem to be a very wise conclusion, for, as will be illustrated in the following pages, the control of cattle-feeding experiments needs a large and efficient staff, since, in order that the experimental results may be reliable, a large number of animals have to be included in the feeding trials. There are so many other more important investigations to occupy the attention of the Agricultural Department that comparative trials of cattle fodders in India must necessarily be for the present shelved. One of the members of the Board of Agriculture even went so far as to remark, and with some truth, that the problem in certain parts of India was to keep the animals alive at all, apart altogether from finding which was the best food.

It must further be remembered that in Europe the farmers can afford to spend more on cattle food than can the Indian cultivator. This arises from the fact that in Europe cattle are kept wholly for milk or for beef production. In India the object is generally the production of animals for work.

Attempts are being made in many parts of India to improve the quality of the cattle. If these are successful the resulting animals will require more food. It would seem that these requirements would be met by an increase in the area and quality of pasture land and in the area of fodder crops grown.

The following account of various feeding experiments in Denmark sets forth the procedure in such work and some of the results which have been achieved.

Danish Feeding Experiments.

The writer has for some years been inclined to think more of the feeding experiments that have been carried out in Denmark than of any other feeding trials known to him. A visit to that country during the past year has tended to confirm his high opinion of these experiments. The work is not as widely known as it deserves to be, perhaps largely owing to the fact that the annual accounts of it are written in Danish and have never been fully translated into English. Certain portions of the reports have been translated into French in a very lucid manner by Mr. Mallèvre.[1] The writer is considerably indebted to these translations in the following account.

Cattle feeding experiments in Denmark were largely stimulated as a result of a difference in opinion in Germany and Denmark as to the feeding value of mangold wurzels. The Germans thought very little of mangolds as a cattle food, while the practical experience of the Danes went to show that they were very valuable for this purpose. As a result the Danes mistrusted the German teachings with reference to other food-stuffs. The Danish farmers approached Mr. Fjord and asked him to institute experiments to determine whether the concentrated foods could not be largely replaced by mangold wurzels.

Since that time the experiments have gone on continuously and many thousands of animals have been employed. Mr. Fjord died in 1891. The experiments now going on deal with milch

1 Société de l'alimentation rationnelle du bétail. *Compte rendu du onzième congrès*, 1907. Do. *Compte rendu du onzième congrès*, 1908.

cattle, pigs, horses, and chickens, and recently experiments have been started on the feeding of cattle for beef. In this article it is proposed to deal only with milch cattle, since in this way a good idea will be obtained of the great care which is expended in order to get reliable results. The pig-feeding experiments have been admirably summarized in Henry's "Feeds and Feeding," page 583.

One important feature of the Danish feeding trials is that they are not carried out at Government Stations with animals specially provided for the purpose. They are conducted co-operatively on a large number of farms under the direct control of the officials of the Royal Veterinary and Agricultural Institute of Copenhagen. These officials weigh and analyse all the food and products. The system has the advantage that it is less expensive to the State, it brings the Government Agricultural officials in closer touch with the farmers, and in many cases the work carried out is at the same time an experiment and a demonstration.

Mr. N. J. Fjord was the pioneer of feeding experiments in Denmark and his experiments were at the beginning purely private and carried out at his own expense. As their importance became more and more evident, the Danish Royal Agricultural Society made a grant of money for their continuation and expansion. Some years later the State also set apart an annual subsidy which has since been continued. The experiments are characterized by the special conditions under which they are carried out. In planning them the advice of the neighbouring farmers is taken, in order to take advantage of local experience, and to ensure that the problems are of local interest, and that the experiments are carried out under practical conditions. The farmers thus take a great interest in the work and therefore have more confidence in the results, since they have seen the work with their own eyes.

The centres of experiment are continually changed according as local conditions lend themselves to one or another series of experiments and hence the work gradually spreads over the whole country.

The work after a time reached such magnitude that it was at last necessary to have a central institution from which to direct it.

The State provided the necessary money, and as a result the Royal Veterinary and Agricultural Institute was built at Copenhagen and began its work in 1888. The experiments, however, still continued to be carried out on private farms just as before but all data are now collated at the Institute, where also all analytical work required is carried out. The Institute has been referred to in a previous number of this Journal[1] and no further description need be given here.

From time to time reports on the work done have been issued. Mr. N. J. Fjord issued 17 such reports on his private work, the last appearing in 1883. Since that time the Laboratory has issued about 80 such reports, all of which are serially numbered. Their subject-matter covers a very wide field such as Dairy Chemistry, Bacteriology, researches into animal diseases, and investigations into animal physiology, besides the feeding trials.

Description of a feeding trial.

It is hoped that the following account will give a good idea of the care expended on these experiments. A farm is selected where a herd say of 150—200 cows is kept. From the herd 40—50 cows are selected, all of which have just had their first calf. Three groups of 10 are then selected in which the animals are as evenly matched as possible. This gives a surplus of 10 to 20 animals of similar type, which can be rejected.

In order to ensure that all the groups are alike they are fed on the same ration for 2—3 months, the milk is weighed and the percentage of fat in it determined, the animals also being weighed every 10 days. If the groups show any difference they are re-arranged and the work is begun over again and continued until all the groups come exactly alike. The ration fed during the above preliminary period contains the substances which are eventually to be compared. Having arranged the groups so that they are alike, they are kept on the same food for a further 10 days in order to see if they still keep alike. We will now take the case of an actual

[1] *The Agricultural Journal of India*, Vol. IX, Part 3, July, 1914.

experiment in which the relative feeding values of maize and wheat were established.

Experimental period.—One group will continue to receive the same ration as before. Another receives an extra ration of maize but no wheat. The third receives an extra ration of wheat but no maize. The experiment continues on these lines for 1—2 months during which time the milk is weighed and analysed, and the animals also are weighed.

Final period.—In this period the animals are all put on to the same diet again which is as nearly as possible the same as in the preliminary period. This period lasts 1—2 months and the yield and composition of the milk and the change in body weight are again determined. During this final period all three groups should give the same quantity of milk with the same quantity of fat and the same difference in body weight. If they do not, then the experiment is rejected. If they do, then one knows that the differences noted in the experimental period are due entirely to change of food.

The same experiment is carried out on 6—8 different farms for 2 years. In the end the comparative values of maize and wheat can be established.

The following is a short summary of an actual experiment. :—

Daily ration. *	Preliminary period.			Experimental period.			Final period.		
				A	B	C	A	B	C
Wheat kilogrammes ..		1·09		2·12	1·06	None		1·03	
Maize		0·89		None	1·06	2·12		1·09	
	A	B	C	A	B	C	A	B	C
Milk per day, kilogrammes..	13·80	13·80	13·80	11·75	11·85	11·55	10·65	10·65	10·65
Daily increase in weight ..	0	–0·2	0·01	0·11	0·13	0·17	–0·29	–0·29	–0·28

* Of course in addition to these the animals were receiving other foods which were always constant, *viz.*, hay, straw, and mangold wurzels.

Hence this experiment was a good one.

The result is that 2·12 kilogms. of wheat produce the same effect as 2·12 kilogms. of maize as a food for milking cows.

Feeding trials on the above lines began in 1887, and up to date more than 4,000 cows have been utilized. Working on these lines it took 20 years to investigate fifteen feeding-stuffs. So far the general results of the feeding trials show that wheat, maize, and bran, all give much the same results in milk production, whilst oil-cake is slightly better. The following weights of the substances named have been shown to be of equivalent feeding value :—

Equivalents.

1 lb.	$\frac{3}{4}$ lb.	$\frac{2}{3}$ lb.	$\frac{6}{5}$ lbs.	$2\frac{1}{2}$ lbs.	5 lbs.	10 lbs.
Wheat. Maize. Bran. Dry matter in mangold wurzels	Sunflower cake.	Cotton cake. Sesame cake.	Molasses.	Hay.	Straw.	Mangold wurzels.

Effect of various foods on the composition of the milk.

The experiments have repeatedly shown that the changes of food have had practically no effect on the chemical composition either of the fat in the milk or of the milk itself. Changes in the composition of the milk are caused to a much greater extent by the individuality of the animal.

This is a convenient place to mention that the Danes find that pasteurisation is a sure way of removing the taints due to various feeding-stuffs from milk.

Control of the experiments.

In some of the more recent Danish feeding work, *viz.*, that described later in this paper, four men are kept specially to guard the cows. Two of these men are always on duty and must never leave the animals day or night. They are educated young men and take the necessary samples. They are also fully instructed in the details and objects of the experiment. During the course of the work these men receive only one half of their salaries. The other half is put by until the end of the experiment. The Laboratory reserves to itself the right to forfeit this half in case of any bad work or of bad faith on the part of the men.

Experiments on cost of production of milk.

Since 1906 experiments have been in progress in order to determine the cost of production of a given quantity of milk when using different food-stuffs. For the purpose of this experiment Red Danish, Jersey, and a cross between these two breeds have been tried. No difference has been established between these classes of cows. However, in order to show what an important line of work this is, it may be mentioned that similar work[1] on 59 farms in Surrey and Kent has shown that the cost of food to produce 1 gallon of milk varies from 3·83 pence to 10·54 pence, the average cost being 6·58 pence.

Researches on the amount of protein necessary for milch cows.

Until some 8 or 10 years ago the Danish feeding experiments had no other aim than that of being of purely practical benefit. Then came a time when certain of the results appeared to differ in some important matters from certain apparently well established physiological theories. In consequence the Laboratory was submitted to very violent attacks. In reply it instituted further researches, the results of which proved the correctness of its former work.

In this way there arose a high class series of researches having for their object the determination of the minimum amount of albuminoid nitrogenous matter necessary to be fed to milking cows. It is worth while to refer more fully to this research work because of the curious facts brought to light. The research has been fully described in the 60th report of the Laboratory published in Danish. In order to explain the origin of the research, it is necessary for us to study Danish agriculture shortly after the middle of last century, at the close of the war with Germany. It then became essential for the farmers, in order to improve their dairy industry, to produce large quantities of milk throughout the year, and not only in summer as heretofore. It was therefore necessary to reform the feeding

[1] First report on the cost of food in the production of milk in the Counties of Kent and Surrey, 1908-9-10. James Mackintosh, South Eastern Agricultural College, Wye.

of their cattle. Hence, to the hay and straw already fed, they added concentrated foods, such as cereal grains and oil-cake. Mangold wurzels, at that time little cultivated, formed a very small part of the rations of cattle. As a result the milk yield was increased by the feeding of large quantities of concentrated food, which however was a very costly proceeding. As the growth of mangold wurzels spread, it was seen that great economy could be effected by substituting them as far as possible for concentrated foods in rations. The question to be decided was to what extent they could take the place of concentrated food in the ration without detriment to the milk supply or the health of the animals. Apart from the large amount of work which would be thrown on the digestive tracts by the assimilation of such large rations of mangold wurzels, a total substitution seemed unthinkable. The mixture of straw, hay, and mangolds is very poor in nitrogenous matters, and the addition of certain amount of concentrated food rich in protein seemed indispensable. From reasons of economy, however, a large number of farmers had pushed the substitution very far, so far in fact that the question arose whether they had not surpassed the safe limit. The opinion of scientific men was divided. The Agricultural Laboratory thereupon submitted the point to the test of experiment. These particular trials were carried out in 1900 to 1901 on 48 lots of ten milch cows each and the results were published in the 55th report of the Laboratory. They led definitely to the conclusion that during winter the substitution of mangolds for cereal grains or oil-cake could be made within large limits without detriment to the production of milk, the maintenance of the live weight or the health of the cows. Animals weighing 475—500 kilogrammes, kept in good condition, gained daily 100—150 gms. and yielded during the winter months 11—13 litres of milk daily, quite indifferently whether they were on a ration of

4·5	kilogms.	.. Straw.
4·5	,,	.. Cereal grains.
& 10—15	,,	.. Mangolds.
or of 4·5	,,	.. Straw.
4	,,	.. Hay.
2	,,	... Cereal grains.
and 40—45	,,	.. Mangolds.

Out of these experiments arose the controversy referred to above. The critics would not allow that a ration such as the last would permit of the production of 11—13 litres of milk daily without loss of nitrogenous substance from the animals' tissues, and hence, without endangering the health of the animals.

In order to follow the discussion further it is necessary to call attention to the minimum amount of digestible nitrogenous matter [1] which various investigators had held to be necessary in an animal's food when at rest and producing no milk, in order that it should maintain its body weight. According to Wolff and Lehmann's tables for a cow of 500 kilogrammes live weight at least 350 grams of digestible nitrogenous matter must be fed daily. This figure agrees with the tables of Kellner. More recent work by Henneberg and Stohmann, G. Kuhn, and Kellner showed that the minimum figure might be as low as 300 or even 250 gms.[2] Armsby's work showed that 3 cattle at rest weighing respectively 420, 450, and 400 kilogrammes which were fed for 71 days on hay were kept in nitrogenous equilibrium by a ration containing 225, 222·2, and 243·8 gms. of nitrogenous matter per day per 500 kilogramme live weight—a mean figure of 230 gms.

As a matter of fact, the figure for the daily amount of necessary digestible nitrogenous matter which was generally accepted by the authorities at that time, for maintaining the body weight of an animal weighing 500 kilogrammes, doing no work, and producing no milk, was 350 gms. If an animal was producing 5 kilogrammes of milk per day, then it was generally agreed that another 350 gms.[3] of digestible nitrogenous matter, or 700 gms. in all per 500 kilogms. body weight, would have to be fed. From this figure it can be calculated that a cow giving 20 kilogms. of milk daily would have to receive a ration of at least 6 kilogms. of cotton cake in addition to mangolds, hay, and straw. Such a ration is practically impossible.

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1 (Nitrogen $\times$ 6·25.)

2 "Maintenance Rations of Cattle." *Bull No. 42. Pennsylvania State College Agri. Exp. Station.* 1898.

3 *Vide* Kellner, Armsby, and Hanson. Hæcker of Minnesota, however, gives a figure much lower than this.

The criticisms against the Copenhagen experiments were based on the above figures. The critics said if you subtract from the total digestible nitrogenous matter which you feed to each animal per day the 300 to 350 gms. generally recognised as necessary for maintaining the nitrogenous equilibrium of an animal at rest and producing no milk, then the remainder will not be sufficient to make up for the nitrogen secreted in the milk, the yield of which, it will be remembered, was 11—13 litres a day in these experiments. Matters are still worse, they said, if it be remembered that in rations rich in mangolds as much as 20 per cent. of the digestible nitrogenous matter is in a non-proteid condition and of less use for nutrition.

Hence one of two things must follow. Either the animals drew on the nitrogen of their own tissues in order to supply the milk, or else there must have been some very large error in the experiments.

Thus confronted by critics the Laboratory had to maintain its reputation. They were certain there was no error in their experiments, and it seemed as though the animals must have lost nitrogen from their body tissues. It was surprising, however, that their body weight had not decreased. It had in fact shown a slight increase. The question then arose whether the animals were laying on non-nitrogenous matter in the form of fat, and by this source of gain masking the loss due to waste of nitrogenous tissues.

The Laboratory decided there was a certain though difficult way of clearing up the problem. This was to feed cows on rations rich in mangolds and hence poor in nitrogenous constituents, that is rations similar to those employed in their feeding trials of 1900-01, and then to keep a careful balance sheet of the nitrogen being fed to the animals and of that given out by them, in their fæces, urine, and milk. Such experiments were carried out, and their results are set out in the 60th report of the station. The experiments were very comprehensive and, by a scale of rations poorer and poorer in protein, showed definitely what was the indispensable minimum that milch cows ought to receive daily in order that they should maintain their body weight and not lose nitrogen from their own tissues.

In all nine cows were included in this experiment and they were kept continuously under experiment from the beginning of November, 1905, till July, 1906, and 200,000 observations were taken. During the course of the experiment each cow received a ration in which the proportion of concentrated food-stuffs (fed as cotton cake) to that of mangolds varied from time to time. The total weight and nitrogen content of all food given was determined, as was also the total weight and nitrogen content of the milk, urine, and fæces. In some cases the proportion of mangolds to cotton cake was very high indeed, and cases were found where the animals had to draw on their body tissue in order to supply the nitrogen excreted in their milk, urine, and fæces.

In order to illustrate the results we will consider the typical case of a cow (numbered 68 in the above report). There were 16 periods throughout the duration of the experiment, during each of which the animal was receiving a varying proportion of mangolds, cotton cake, hay, and straw. During each period the daily amounts of nitrogen in the food, fæces, urine, and milk were determined. The amount of nitrogen in the food varied from 151 gms. daily to as much as 329 gms. daily. For our purpose we will consider the 8th to the 13th periods which lasted from the 6th February to the 25th April, 1906, or 79 days in all. During this time the cow consumed a ration rich in mangolds and poor in cotton cake. The actual ration was throughout somewhat as follows :—

5	kilogrammes	of straw.
2·5	,,	,, meadow hay.
1·25	,,	,, decorticated cotton cake.
4·5	,,	,, mangolds.

The animal's weight was 453 kilogrammes at the beginning and 457 kilogrammes afterwards. Hence its weight kept fairly constant. The average production of milk was rather over 13 litres per day. Its average daily intake of nitrogen in its food was 191 gms. It excreted in its fæces 90 gms., in its urine 34, while the milk contained 59 gms., making a total of 183 gms. of nitrogen. Hence the animal's body was gaining daily 191—183 = 8 gms.

of nitrogen. There is therefore here a cow, which, during $2\frac{1}{2}$ months, has suffered no loss in weight of its own nitrogenous tissues and has given an average daily yield of 13 litres of milk, and that on a ration rather poorer, from the nitrogenous point of view, than that fed to the cows in the experiments of 1900-1. As has been seen these rations were denounced by the critics as being too poor in nitrogen for animals yielding 11—13 litres of milk. It will be convenient to call the reader's attention here to the fact that of the nitrogenous matter fed in the food only about 50 per cent. is digestible. Hence the above animal was receiving 95·5 gms. digestible nitrogen daily equal to 95·5 × 6·25, that is, 596 gms. digestible nitrogenous matter. According to the critics it should have received (350 gms. + $\frac{350 \times 13{\cdot}28}{5}$)[1] × $\frac{455}{500}$ equal to 1,163 gms.

The experiments thus upheld the previous feeding experiments of 1901-2, and also showed that the accepted figures for the amounts of nitrogenous matter required by milking cows were much too high. It may be of interest here to note that the experiments further showed a close connection between the amount of nitrogenous matter in the food and the amount of nitrogen excreted in the urea. As the food became less nitrogenous so did the nitrogen content of the urine decrease.

Before leaving the subject of the minimum desirable nitrogen content of cattle foods, reference may be made to work at the Minnesota Agricultural Station by Hæcker and described by Benedict.[2]

Two lots of cows were taken. Lot A received a ration containing the normal quantity of protein, and lot B one much poorer in nitrogenous matter. The experiment spread over three years. For the first two years there was no observable difference between the two lots. During the latter half of the third winter, lot B began to get thin and their skin became hard to the touch, a sign of bad nutrition. The amount of nitrogenous matter in their food was increased and they at once recovered their normal state. Thus up to a point Hæcker's experiments confirm the Danish ones, but

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[1] Its daily yield of milk was 13 litres, roughly 13·28 kilogms. The animal weighed 45 kilogms. ; hence fraction $\frac{455}{500}$.

[2] Benedict. *American Journal of Physiology,* 1906.

they go beyond them by showing that over long periods a low protein diet is not desirable. Practically, Hæcker's results, however, have no significance to the Danes, for it is only during the winter months that they feed low protein diets of mangold wurzels. During the summer months their animals get plenty of pasture and green fodder, which contain sufficient nitrogenous matter.

Hence, this series of Danish experiments establishes the fact that the Danes can substitute during the winter less expensive foods such as mangolds for expensive foods such as cotton cake without decreasing the yield of milk or endangering the health of the cattle.

It may be of interest to remark that Dr. Hindhede who was responsible for much of the above work has recently turned his attention to human nutrition. His results[1] seem to show that here again the nitrogenous content of human food is much too high.

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[1] Hindhede. *Protein and Nutrition—an investigation.* Ewart, Seymour & Co., London.

THE IMPROVEMENT OF CANE CULTIVATION IN THE SOUTH CANARA DISTRICT.

BY

H. C. SAMPSON, B.Sc.,

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In 1907, when little was known of the agricultural conditions of the West Coast, a trial crop of sugarcane was grown on the newly opened Agricultural Station at Taliparamba in North Malabar. This was an entirely new crop to this part of the West Coast, thus the methods of cultivation adopted were suggested by the experience gained in the drier districts of the East Coast. Considerable stress was laid on two points, *viz.*, adequate manuring and drainage. On the East Coast it is the practice to manure very heavily either with cattle manure and green leaves or, in places where the supply of these is insufficient, with oil-cakes either castor or groundnut. Cattle manure is not available in any quantity in Malabar and the price of oil-cakes is prohibitive. Fish manure (beach-dried sardines) is, however, plentiful in most seasons at reasonable rates and this was used as a manure for this trial crop. Two varieties were tried, *viz.*, Red and Striped Mauritius. These were planted in trenches 4 feet apart in March and were earthed up before the monsoon broke in June. As the South-West Monsoon is very heavy (the rainfall for June, July, and August averages about 100 inches) and the air is laden with moisture, particular attention was paid to drainage. Deep trenches were dug between the rows of cane and high ridges were formed along the rows. These trenches were all connected with a deeper trench which carried off all surface water. The growth of this crop exceeded all expectations and was as good as that of the heaviest crops on the East Coast.

After the monsoon of the same year, when touring for the first time in the South Canara District, the difference between the pale and stunted crops there and those raised on the Agricultural Station in the adjoining district was very marked indeed. A few sets were accordingly distributed at the next planting season through the District Agricultural Association of South Canara and these were planted on one of the backwater islands in the river near Mangalore. These crops were inspected later in the season and though the Red Mauritius proved itself to be a much more vigorous variety than the local cane and gave what in the locality was considered an excellent crop, it could not be compared with the luxuriance of the crops on the Agricultural Station. This was attributed (and rightly as it afterwards turned out) to the lack of adequate drainage and manuring. An officer of the Department was then sent to tour in the cane tracts of the district to get into touch with actual cane cultivators. A few of these in the Mangalore, Udipi, and Coondapur Taluks were induced to try these canes, and further these cultivators were induced to adopt the methods of cultivation and manuring which had proved so successful on the Taliparamba Agricultural Station. In a few cases one of the permanent labourers from the Agricultural Station was sent to assist in the planting. The results of these trials showed that just as good crops of Red Mauritius canes could be grown in South Canara as on the Agricultural Station.

Thus, by introducing a new cane and insisting on certain methods of cultivation, it was possible to introduce better methods of cane cultivation which would have been practically impossible if attempted in the first instance with the local cane. Subsequently the cultivators, finding that wider planting, better manuring, and adequate drainage gave such satisfactory results with the new cane, successfully adopted these methods of cultivation for their local canes. The Red Mauritius, however, at once found favour on account of its great vigour, and it is generally stated by those who have cultivated it that it yields half as much again as the best local variety. It may be asked, however, why the Red Mauritius, if it gives such good results, has not entirely supplanted the local cane.

There are two reasons, firstly, much of the thick cane grown in the district is sold for chewing; and for this purpose the local thick soft-rinded canes are much preferred to a hard-rinded cane like the Red Mauritius. The cultivating Roman Catholic Christian, among whom cane cultivation is practically confined, is usually only a petty cultivator, and depends on his industry for his livelihood, and thus has to live a hand-to-mouth existence. By selling the local cane in small lots for chewing, he can manage to exist until the bulk of the crop is ripe for making jaggery. Secondly, the local thick canes, accustomed as they have been for centuries to very close planting, do not tiller freely like the Red Mauritius, thus they ripen more evenly, the canes being practically all of the same age. At the end of the monsoon jaggery is always scarce, especially in those parts of the district which are only accessible by sea; for during the monsoon all the ports are closed. Thus considerably higher prices are paid for jaggery immediately after the monsoon and the local soft-rinded thick canes are then in considerable demand for milling.

It seems probable therefore that though the bulk of the crop will in the future be Red Mauritius there will always be a considerable area of the better local canes under cultivation. The fact, however, that the Red Mauritius is a hard-rinded thick cane has meant, and will mean in the future, a considerable expansion in the area under cane. Up till the introduction of this variety, the cultivation of thick canes was practically confined to the islands in the river backwaters, for if grown on the main land very considerable damage was always done to the crops by jackals. The Red Mauritius cane being proof against the attack of these has meant that thick canes can replace and have in many places replaced the *Karri kabbu*—the local hard-rinded red cane. This has greatly extended the possibilities of profitable cane cultivation.

When Red Mauritius canes were first successfully grown a new difficulty arose in milling them. Up till that time, the iron cane mill was unknown in the district and it was found that the local wooden mill could not properly crush these thick hard canes. If this cane was to stay it was essential that a better mill should be

introduced. Although iron mills have entirely replaced the old wooden mill on the East Coast, the introduction was a real difficulty in South Canara owing to the poverty of the cane growers. Moreover there were serious misgivings in the minds of the people that the iron mill would need a much heavier draught than their cattle could manage. After considerable inducement one or two men who were professional jaggery makers were induced to purchase iron mills, when the better extraction of juice and the more rapid work soon became evident, and all doubts as to the capacity of their cattle to drive the mill were removed.

The very fact, however, that these iron mills did more efficient work led up to another difficulty. It was found that the primitive methods in vogue of jaggery making could not cope with the rapid extraction of juice, and, if these mills were to come into general use, it was necessary to improve the methods of jaggery making. Further, improvements in jaggery making were essential if the area under cane was to be maintained, let alone increased. The primitive hearths had no through draught, while the pans for boiling were very small. Thus there was not only a great waste of fuel through incomplete combustion, but there was a great waste of heat. Even as far back as 1801 Buchanan wrote "the want of firewood is the greatest obstacle to this cultivation."

Accordingly in 1911 an officer of the Department who had a practical knowledge of jaggery making was sent to this district to erect proper furnaces and to introduce larger pans for boiling juice. These were erected in centres where the iron mill had been introduced, and, meaning as they did a great saving in fuel and thus in the cost of preparing jaggery, they have generally come into favour while the old wooden mill has now practically disappeared from the district.

These last two years have seen a steady advance in the sugarcane industry of South Canara. There has been a general improvement in the methods of cultivation. The canes are planted further apart, attention is given to manuring, drainage, and weeding, and much greater economy is effected in the manufacture of jaggery. The area in the district grown with Mauritius canes is this year

reported to be 194 acres, or 10 per cent. of the total normal area. This does not seem at first sight a very large item, but when it is considered that an individual holding of cane probably averages 10 to 15 cents this means that the Department has got into touch with, and has gained the confidence of, a very large number of hardworking small ryots, while the fame of these new varieties of cane has spread not only throughout the district but into the adjoining territories of North Canara and Mysore.

Reading Buchanan's[1] account of the cane cultivation in this district written in 1801 and comparing it with the cultivation as practised in 1908 it is evident that no innovation in the methods of cultivation had been introduced within that period. The only innovation apparently had been the introduction of a new variety called locally *Dassa Kabbu*—the *Nammalu* of the East Coast—into the Mangalore Taluk. Yet within a period of 5 years the Department has been able, by the introduction of a new variety of cane, to effect many improvements not only in the cultivation but also in the manufacture of jaggery.

Granted that the cane crop is of minor importance in this district, the work is of much greater significance than is at first apparent, as it has paved the way for other and more important district work; and the ryots now realize that the officers of the Department are not merely Government officials, but have a practical knowledge of farming, and can by their advice and guidance render them considerable assistance in improving their local methods of agriculture.

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[1] Buchanan's *Mysore, Canara, and Malabar.*

NOTES ON THE CULTIVATION OF BERSEEM.

BY

CAPT. A. S. MARRIOTT,

Military Farms Department.

UNDER the name of Berseem are included the various kinds of clover grown in Egypt, which are all varieties of *Trifolium Alexandrium.*

The growth of this crop is very advantageous from an agricultural point of view, for the following reasons :—

(*i*) Berseem tends to prevent the diminution of humus in the soil.

Decomposition proceeds very rapidly in India, so that, with the aid of irrigation, there is a tendency to serious loss of humus. The roots of berseem and a little stem are left in the ground in all cases.

(*ii*) It is very successful in opening up the soil.

(*iii*) It possesses a high manurial value as belonging to the *Leguminosæ* family. It has the power of fixing the nitrogen of the air, and converting it into plant food.

The roots of berseem have been found to contain about 55 lbs. of nitrogen per acre. If, however, the crop is allowed to seed, the roots lose most of this nitrogen, which goes to assist in the formation of the seed.

(*iv*) It is excellent as a food both for horses and dairy stock.

In Egypt during its period of growth it forms the only food for stock.

Varieties.

There are four chief varieties of Berseem, *viz.*, Fahl, Saidi, Miscawi, and Khadrawi ; of these only the two latter are

worthy of consideration for Military Farms, *viz.*, Miscawi and Khadrawi.

The berseem grown in Lahore is almost certainly Miscawi, which is by far the most important variety. It is tall, luxuriant in growth, and yields an astonishing amount of green food. It is very largely grown under perennial irrigation, requires plenty of water, and will give four or five cuttings and a seed crop.

Khadrawi is not largely grown in Egypt. This variety resembles the Miscawi, also requires a lot of water, but gives more cuttings.

Cultivation.

The land should be prepared more or less as for an ordinary *rabi* crop, but one or two ploughings with a native plough are as a rule sufficient.

Manures are not necessary as the growth is quite satisfactory without them. It will grow well on most cultivated soils. The plant will not grow on salt lands, but is extensively used on lands in the process of reclamation after *Panicum Crus-Galli*, or rice. When *Panicum-Crus Galli* or rice has been successfully grown on land, it is followed by a crop of berseem. If this grows well, the land is considered reclaimed, as all other crops follow. Unreclaimed land is generally poor in organic matter and nitrogen, and for this reason berseem growing is extensively advocated.

The seed should be sown about the middle of September to the extent of 40 lbs. per acre. The land is heavily watered (about 2″ deep), and the seed is broadcasted on the water. It sinks to the bottom and, the water having disappeared, the seed quickly germinates. The day before sowing, the seed should be soaked overnight, and sown about midday.

When the seed is sown early and gets the benefit of the warm weather the plants grow rapidly. There is danger in early sowing as the young plant is subject to the attacks of surface caterpillars and cotton worm.

Late sowing, however, may retard the crop greatly, since cold weather in the early stages will almost stop the growth. About

two to three waterings will be required before taking the first cutting (45 to 80 days after sowing, dependent on the weather). The crop should be cut when about 15 to 18 inches high.

The crop should not be in actual need of water when cut, as it is important that the soil should be just moist enough to stimulate the plant to grow again when cut. This is best done by watering about ten days before cutting. A few days after cutting, the crop is watered again, and usually gives a second cutting in from 35 to 40 days.

With early sown berseem as many as five or six cuttings can be obtained.

The early cuttings of berseem contain a very large percentage of water (about 86 per cent), and for that reason are not suitable for hay-making. The later cuttings can be made into hay or "Driss." These cuttings contain less water and readily dry into hay. The process is very simple, the crop is cut and left to dry on the ground, and then carried. It is usual, if seed is required, to allow, in the case of early grown berseem, the fifth crop to flower and seed, and, in the case of late grown berseem, the fourth crop.

Seed.

The average sample of seed usually contains some 7 per cent. of impurities, mainly chicory and wild mustard. These are both edible, but opinions on their desirability are divided. The Agricultural Officer, North-West Frontier Province, states the presence of chicory is desirable as it prevents "hoven"; the Egyptian authorities, however, state that it tends to cause scouring, and to kill out the berseem. It was noted that after each cutting the amount of chicory decreased.

Report on growth in India.

The seed was first sown in the winter of 1912-13 at Ferozepore and Lahore.

At Ferozepore it was sown on manured land ($1\frac{1}{3}$ acres), and was most successful, giving an outturn of 34,977 lbs. or 437 maunds per acre.

At Lahore, owing to a change of staff, nothing was known of the seed having been ordered until about a week before its arrival. The only land available was some $2\frac{1}{4}$ acres of inferior land, on which a crop of rice had been grown in the previous *kharif*. The plot was ploughed twice, and the seed sown. The outturn was fair, and in conjunction with results obtained at Ferozepore it was decided to continue its cultivation.

Ten maunds of seed were obtained, and one maund was transferred from Lahore to Multan and Lucknow Grass Farms.

The seed was sown between the 1st and 10th of October, and the first cutting was ready about the 20th November.

The seed was obtained originally from the Deputy Director of Agriculture, Sind, who cannot now supply it, but seed can be obtained from the Sind Reclamation Company, Mirpurkhas, for Rs. 16 per maund.

As the seed is not harvested in Egypt until June or July it is difficult to obtain it in India before October, but this year it has already been obtained, and will be sown earlier, when even better results should be obtained.

Outturn.

Lahore.—The total outturn from 15 acres was 537,143 lbs. exclusive of $\frac{1}{2}$ acre left for seed which yielded 150 lbs. of seed, giving an outturn (green) per acre of 35,809 lbs. The fodder was issued at 35 lbs. equal to 20 lbs. of hay, so the outturn on a hay basis per acre was 20,462 lbs. or 255 maunds.

The $2\frac{1}{4}$ acres previously sown in the year before were re-sown and gave six cuttings as under :—

1st Cutting	11,200 lbs.	
2nd Cutting	18,073 ,,	
3rd Cutting	28,763 ,,	
4th Cutting	31,364 ,,	
5th Cutting	24,552 ,,	
6th Cutting	6,458 ,,	
Total ...	120,410 ,,	or 53,515 lbs. per acre

equivalent to 30,580 lbs. of hay or 382 maunds.

This conclusively proves the value of soil inoculation with regard to this crop. The principle now to be followed is, where land has given but a poor crop of berseem, to re-sow with berseem the next year when, if the crop is successful, the land may be considered as good for all crops. The $2\frac{1}{4}$ acres in question will now be put down to grass. A small amount, *viz.*, 4,200 lbs. of green berseem, was made into hay, but only gave an outturn of 600 lbs. The Divisional Veterinary Officer bought this, and stated the hay was an excellent fodder, but the loss is heavy and as in the case of lucerne hay it tends to become very brittle.

Multan.—Two and a half bighas (5,000 sq. yds. or 1·033 acres) were sown on the 1st of November. The land had been heavily manured and the resultant outturn was 97,345 lbs. in three cuttings. The outturn per acre was therefore 94,235 lbs. green = 1,178 maunds, which is equivalent to 674 maunds per acre of hay.

The crops were retarded by frosts during the month of December.

Remarks.

The value of berseem in reclaiming land has been fully proved.

The eagerness with which all classes of animals devour this fodder is phenomenal.

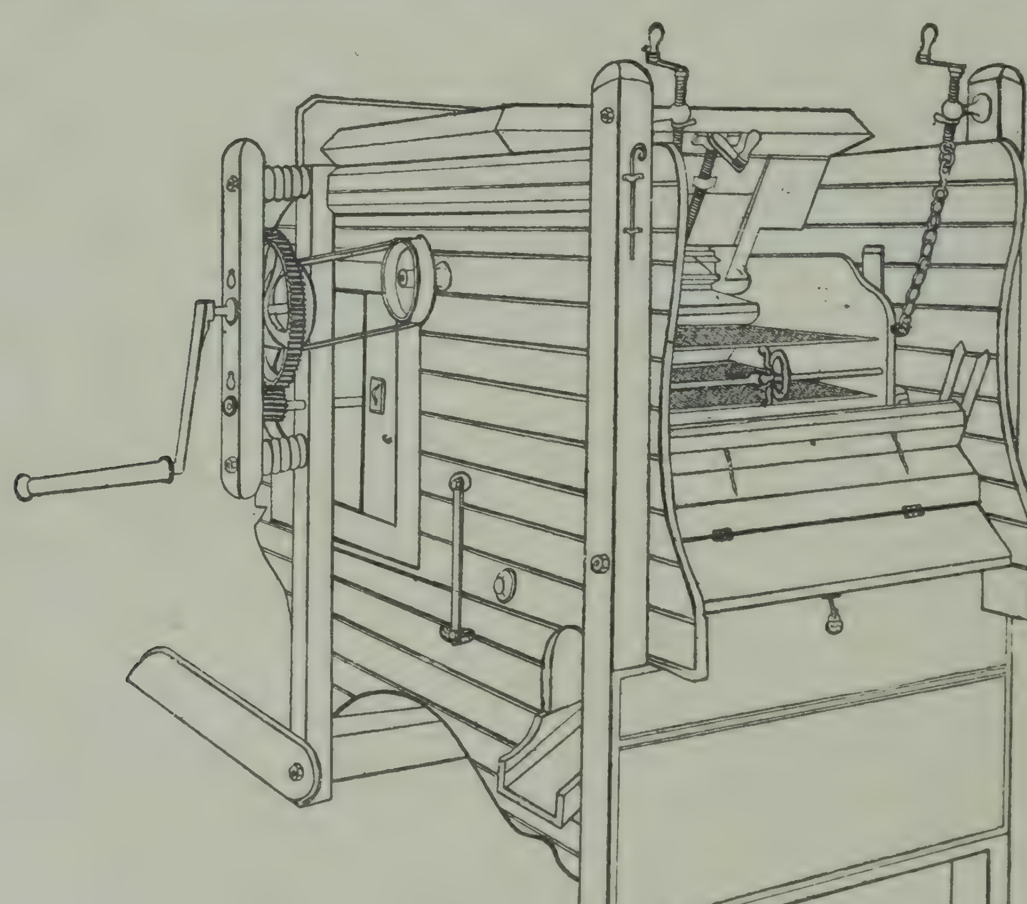
The crop becomes available for issue before lucerne and the ordinary *rabi* crops are ready.

The Text-book of Egyptian Agriculture has been the main source of all the information given above.

[Importers of seed should endeavour to obtain seed free from dodder which is a serious pest of this crop in Egypt and has been imported thence into all countries which have introduced berseem (see *Agricultural Journal of India*, Vol. VIII, Part III, p. 306.)—EDITOR.]

NOTES.

A WINNOWING MACHINE.—A NEW Winnowing Machine has been recently obtained for the Central Farm, Coimbatore, and has been given a short trial during which it proved quite satisfactory. It is too expensive a machine for recommendation to ordinary farmers, but for work on a Seed Farm or Experimental Station it may be recommended. The selection of sieves was made, on



consideration of a series of actual samples by the makers themselves, and should tackle all grains.

The machine is made by Thomas Corbett of the Perseverance Iron Works, Shrewsbury. It is known as the A. 3 winnower with

PLATE II.

ARRANGEMENT OF BOXES FOR SEED POTATOES.

$20 \times 20''$ riddles, less No. 2 and 3, fitted with portable bottom frame and a fluted iron roller. This feed roller was added, and the writer thinks it justifies itself, because it has been found difficult to get women to feed regularly, and no machine will do its work well otherwise. A blowing tray, 2 extra riddles 6×6 and 8×8, 2 extra trays 10×10 and 16×16, and 2 screens 10×10 and 16×16, were included, giving a range which should cover most grains likely. The total cost of this machine and extras, including packing and freight to Madras, was approximately Rs. 250.—(R. CECIL WOOD.)

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STORAGE OF SEED POTATOES AT LANDHI GOVERNMENT FARM NEAR KARACHI.—There has been much complaint in the potato-growing district round Karachi of the difficulty of storing seed potatoes. Potato moths, fungus, and shrivelling cause a considerable amount of damage each year. The area of potato cultivation is generally under 2,500 acres per year. In September and October Italian seed is available in Karachi, but for hot weather crops seed must be stored.

In the past, keeping in gunny bags and spraying with crude oil emulsion have proved unsatisfactory.

A trial was made in the present season of storing in boxes of a similar pattern to those used in the early potato districts in Britain. The boxes are made of $\frac{1}{4}''$ deal wood, and cost about 3 annas. The godown has a spring wire gauze door, and the small windows are covered with gauze. 300 boxes were used.

The average weight of seed potatoes put in each box was $6\frac{2}{3}$ lbs.

The total weight of potatoes put in boxes was 2,000 lbs.

They were filled on the 10th January 1914.

Potatoes were planted from the boxes on 10th June 1914.

Then the average weight in each box was	..	$5\frac{13}{15}$ lbs.
Total weight of potatoes planted was	.. ..	1,760 ,,
Loss	.. ..	240 ,,

This equals 12 per cent. on amount stored.

The potatoes in the boxes are easily got at and inspected.

Rotten potatoes were removed once a week.

The boxes are 2″ long and 1″ broad. They are $7\frac{1}{2}$″ high at the ends. The potatoes sprout in the boxes and are planted direct from the boxes without breaking the sprouts.—(G. HENDERSON.)

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A NEW DRAG HARROW.—This harrow is principally intended to break the clods which form one of the principal difficulties in working black soil, especially in the sugar-cane tract where such clods hinder the further preparation of the land.

The local implement *Maind* used for breaking clods does not deal with these effectively and everywhere in the Deccan there is a cry for an implement to do this operation more successfully.

FIG. 1.—THE FRONT PART OF THE "DRAG HARROW."—THE HARROW PROPER.

Of the foreign implements the "Disk Harrow" and the "Norwegian Harrow" are found to do the work of clod crushing fairly well. They must be used immediately after ploughing to get the

desired effect. If the clods dry, the disks cannot break these properly. The "Norwegian Harrow" does little better.

The "Disk Harrow" costs from sixty to one hundred rupees. The "Norwegian Harrow" costs about two hundred rupees. Both these require four bullocks to draw in the soils of the Deccan.

In the present implement an attempt has been made to combine a harrow and a planker or a float to break the clods effectively.

The front part or harrow proper (see Fig. 1, page 88) tears the clods and the float pulverises them. The former is made of wood with iron teeth and can be repaired locally. The cost of the wood may be up to fifteen rupees, but generally the cultivators do not have to purchase wood for implements. They use *babul* wood from their farms. The teeth may cost about six rupees. This instrument, as devised, is $5\frac{1}{2}$ feet long by fifteen inches wide, by five inches deep, and it carries thirteen teeth in two rows set alternately. The distance between the teeth in the row is nine inches, and since they are set alternately they cut tracks four and a half inches apart. The teeth are strong; they are curved and flattened at the point. They break and tear the clods with fair success.

The harrow is provided with two wheels which can be lowered or raised by means of a lever.

The harrow has done excellent work even without the lifting arrangement shown in the illustration, but it was found too heavy to lift for cleaning or for relieving it from weeds, etc., when worked in moist soil as a "cultivator." If the lever, with which the harrow is provided, is pulled back, the harrow is lifted and can then easily be relieved of the weeds.

The wheels can be used to adjust the depth and to bear the weight of the harrow. They are, moreover, very useful for removing the implement from one field to another.

The float or planker (Fig. 2, page 90) goes behind the harrow and crushes the lumps effectively which have been already partly broken. The planks are so arranged that they catch and strike the clods as it is drawn over the soil. The planks lap over one another, presenting edges which break the clods and do not merely push them into the soil as the *Maind* does.

Three planks $5\frac{1}{2}' \times 7'' \times 2\frac{1}{2}''$ are fixed in the two runners in a slanting direction, each just overlapping the edge of the plank in front as shown in the picture. The lower edges of the planks are protected by means of iron bands.

When the complete implement (Plate III) is worked the harrow carries the float behind it. The float balances the forward pull on the harrow and enables it to hold in the ground without

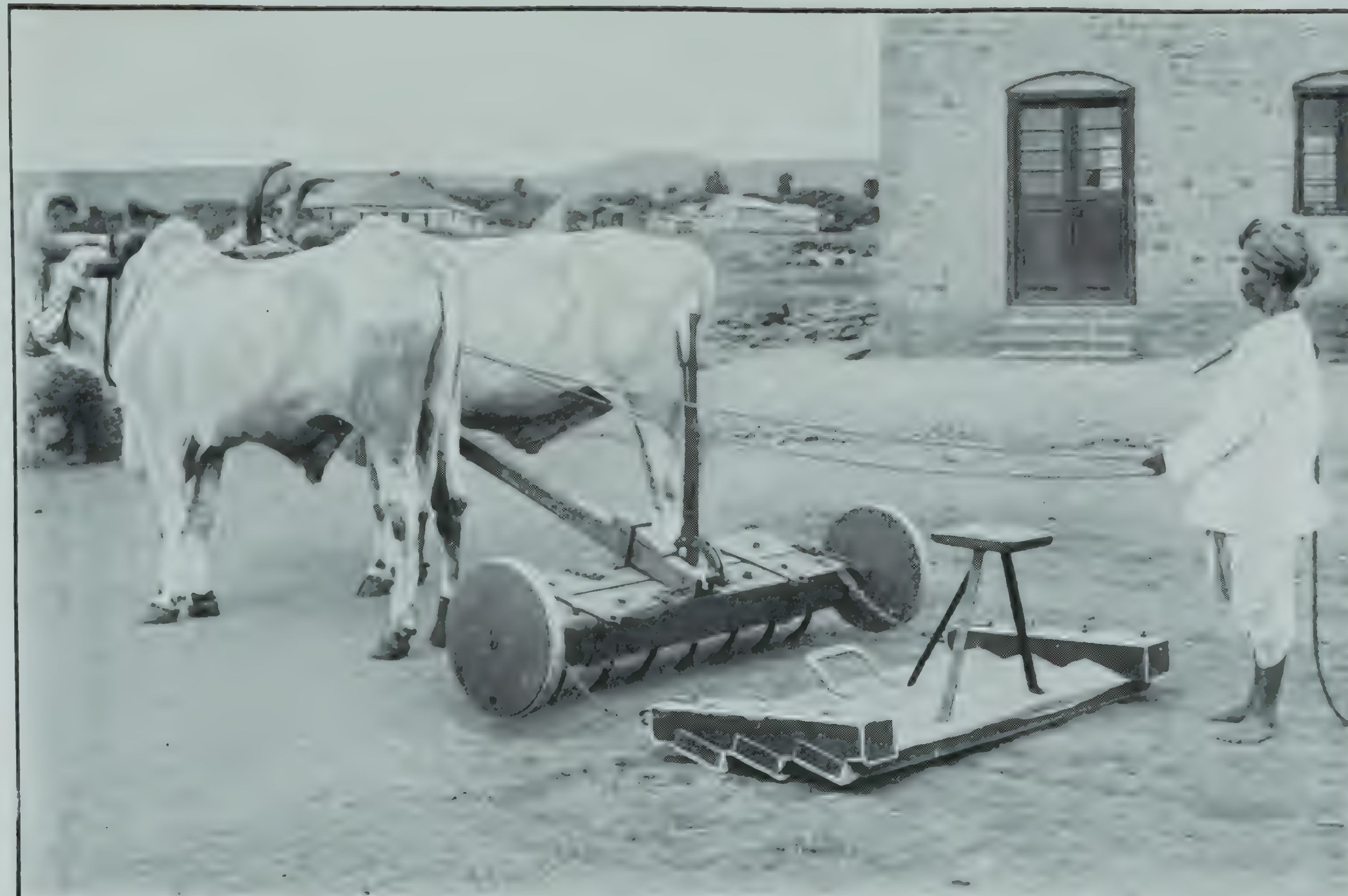
FIG. 2. THE REAR PORTION OF THE "DRAG HARROW."—THE FLOAT OR PLANKER.

jumping about. Four bullocks are required to draw the implement.

The front portion (harrow, Fig. 1) can be used to stir the soil deeply as a preparation for *kharif* sowing. Four bullocks will be required for this in damp heavy black soils.

The float (Fig. 2) when used alone makes an admirable leveller and is a decided improvement on the log harrow. When worked alone chains may be used. Only two bullocks are required since it is used when the soil is dry.—(P. C. PATIL.)

PLATE III.



THE DRAG HARROW.
(Complete in working order.)

Improved fruit boxes.—The packing and transportation of fruit under Indian conditions was dealt with in some detail in a recent issue of this Journal (Vol. VIII, Part III, 1913). In the paper in question, a detailed account was given of the various packages taken up by the trade at Quetta together with a statement of the general lines of progress likely to yield useful results in the immediate future.

During the present year, further progress has been made at the Quetta Fruit Experiment Station in designing suitable fruit packages for the five-seer parcels rate. In the original Quetta peach crates, chip compartments were used for each peach and laths were employed for the top and bottom of the box. The separate laths were found to be unsuitable in practice on Indian railways on account of the comparative ease with which thefts in transit could be carried out without risk of immediate detection on delivery of the crates. Further, the labour of making the separate chip compartments was considerable.

Two changes have been made in the Quetta peach crates by which the above disadvantages have been entirely removed. In place of the separate chip compartments, a collapsible cardboard fitting has been used instead. This folds flat and is imported ready for use. Two box boards, which leave a ventilation space of about one-third of an inch down the middle of the box, are used instead of the narrow laths. These cannot be removed in transit unless the lead seals are broken. The arrangement will be clear from Fig. 1

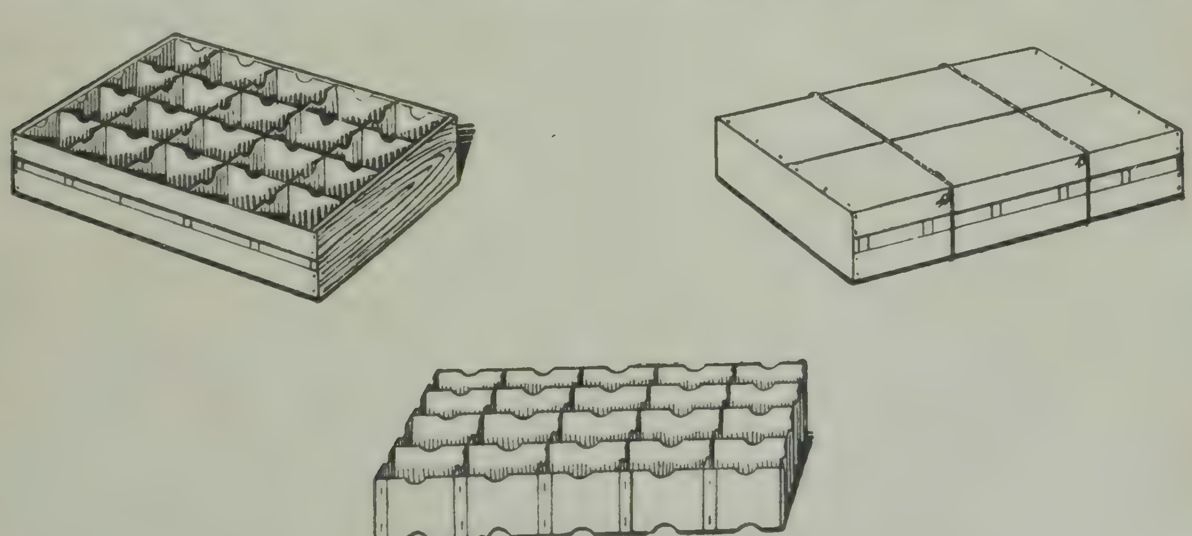


Fig. 1. Peach crates with cardboard compartments.

which shows on the left, a crate with the cardboard fitting inside; on the right, a crate ready for despatch with a separate cardboard fitting below.

During the past year the whole stock of these improved crates, nearly five hundred in number, were at once sold to the trade and proved entirely satisfactory under Indian conditions.

At the same time, a fruit box on the same principles as the above, but made entirely of cardboard, was put on the market at Quetta. The whole of the outside of the box consists of a single piece of cardboard and the boxes can be set up very rapidly. The separate compartments are of cardboard on the same principles as those shown in Fig. 1. With these cardboard boxes, thefts in transit are quite impossible. One hundred and forty-four of these boxes were imported, and of these only a few were offered for retail sale as the majority were at once bought up by the fruit merchants. Judged by the demand in the Quetta market in 1914, cardboard fruit boxes are likely to become exceedingly popular in India and steps have been taken to import a larger number for use at Quetta next year.

The crates introduced at Quetta for twenty medium and fifteen large peaches are being adapted for other fruits by the simple expedient of changing the inside cardboard fittings. The fifteen peach crate with three and a half inch cube compartments will serve not only for large peaches but also for dessert apples, apricots, cherries, and plums. A four-compartment cardboard fitting renders these crates suitable for grapes. The twenty-peach crates, with three inch cube compartments, are suitable for ordinary peaches, nectarines, and medium-sized apples. These two crates, one of which will have two kinds of cardboard fittings, will serve for five-seer parcels of most of the fruits grown at Quetta which are suitable for long distance transport. Work is now in progress to ascertain the cheapest source of the materials required for these packages and to compare Indian with imported wood.—(A. HOWARD.)

In the July (1914) number of *The Tropical Agriculturist* there is a very instructive article entitled "Improvement of Rice by Selection in Java," by Dr. J. Van Breda De Hann, which should prove interesting reading to those engaged in similar work in India. The article summarizes in some detail the important work which has been carried on at Buitenzorg during the past ten years by Moquette and Van der Stok, and the results achieved. The first work undertaken was to obtain as complete a knowledge as possible of the different species and varieties of rice cultivated in the Island. Samples were collected from all parts and roughly classified according to the external characters of the ears, grain, awns, etc., after dividing the samples into the two broad classes of glutinous and non-glutinous. This work is said to have resulted in a collection of 6,400 samples, which were divided into 751 groups of non-glutinous and 141 of glutinous. The figures give some idea of the magnitude of the task. These samples were then grown in pure-line culture for a series of years, and the permanence of the characters accurately determined. In this way it was found, as is generally the case, that apparently homogeneous samples were in reality composed of several very distinct types, and to obtain a thorough selection, one must begin with pure cultures. As an instance of what has been done by "pedigree" cultures, it is stated that from a variety called "Tranggerang" types have been isolated which yield 2·6 tons per acre (or over 74 maunds). It would be interesting to know whether this extraordinarily high yield has actually been obtained in field tests on a practical scale, or whether the yield is only that of small "pedigree" plots estimated to the acre, a very different thing.

There is an interesting paragraph on the popularization of the results. It is stated "In order that the results may be of immediate application to the cultivation of rice in Java, it is proposed to establish seed farms in several districts of the Island, since the results which have been obtained up to the present by a comparison of pure lines with one another only hold good for lands which are subject to the same conditions of climate, soil, and irrigation as the selection plots at Buitenzorg. It has on other occasions been

observed that some varieties of rice are very sensitive to changes in these conditions, especially as regards their time of ripening, yield, etc.; and it has rightly been remarked that figures of yield obtained at Buitenzorg ought not to be considered rigorously applicable everywhere. This has been fully understood by planters and they have begun on their own lands to cultivate plants for seed production in accordance with the system of isolation. The same method must be employed by the Government, if it desires to work in the interest of the native cultivator."

"In the seed farms, the cultivation of the varieties of rice which exist in the immediate neighbourhood and form the 'population' must be undertaken, then the culture in 'pure-line' which will lead to a selection of the better types, the seed of which will be subsequently distributed under certain conditions to the natives.

"The selection plots at Buitenzorg will afford the necessary information, but the aim of the Station will always be primarily the elucidation of the scientific side of the question of selection and the importation of new varieties from other countries."

Other paragraphs discuss the flowering of rice, the biology of the rice flower, mechanical selection and hybridization. In summing up, the following statement is made :—

"We have already seen that one must not remain content with selection only, but that seed farms must be instituted in order that the best use may be made of the results.

"From efforts which have already been made in this direction and which prove that the native cultivator is well able to appreciate the value of better seed, it may be expected that those interested in the cultivation of rice will follow with the closest attention, and will derive very great benefits from, these seed farms. It may be asked whether it is not sufficient to point out the way and to prescribe methods by which the cultivators may arrive at an improvement of the rice plant, by using better seed for example, and leaving to ordinary practice the task of applying the facts discovered.

"The answer to that is that the application of methods for the improvement of grain demands in the first place a knowledge of the

scientific principles on which the method is based, and therefore it is not a task which can be undertaken by anyone. And, secondly, as has already been proved in Europe, where the farmers in general have some knowledge of the principles of agriculture, the work of improvement of cereals demands so much attention and close control that it cannot be carried out in association with the ordinary work of cultivation.''—(G. P. HECTOR.)

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* *

BENGAL BEANS A NEW FODDER.—THE June (1914) number of the *Bulletin of the Department of Agriculture, Trinidad and Tobago*, has a note by Mr. Shrewsbury, Acting Government Analyst, on this subject. The beans received for examination were oval and rather flat, about $16 \times 10 \times 5$ m.m., with black shining testas and a white oblong crateriform hilum about 7 mm. in length. The Acting Director of Agriculture to whom the sample was submitted for botanical examination is inclined to call them *Stizolobium arterrimum*, but he doubts whether this is not a synonym for *Stizolobium utile* the *Mucuna utilis* of Wallich, which has been cultivated extensively in Mauritius and Tasmania as a table vegetable and as a fodder for cattle. As *Stizolobium niveum*, a closely related plant to *Stizolobium arterrimum*, causes vomiting and purging, and as *Stizolobium arterrimum* has not been known to be used for fodder or as human food, there were good grounds for suspecting the sample of toxic properties. But the search for cynogenetic glucosides by the method of Henry and Auld has resulted in no evidence of their presence. It is also reported that no evidence was found of other poisonous glucosides, saponins, fats, alkaloides, vegetable ptomaines or toxalbumins.

Several feeding experiments with guinea-pigs, in which the animals were fed with liberal quantities of the whole meal, the ground testas of the beans, the bean flour deprived of the testas, and various solvent extracts of the whole meal, are reported to have given entirely negative results. There was no indication of any toxic effect, the guinea-pigs exhibiting no abnormal symptoms, and their excretions continuing perfectly normal in character.

It is stated that the whole meal from the beans has a clean and pleasant appearance. The interior of the bean, which is easily ground, forms a very pale yellow powder, which is mottled by the shining fragments of the black testas. The taste and odour are pleasant and closely resemble that of pea-meal.

On analyses the Bengal bean has been found to be somewhat superior in feeding value to French, Lima, or Java beans and that like these beans its nutritive properties are principally due to the high content of carbohydrates and proteins. Owing chiefly to its low percentage of fat, its value is, however, considerably less than that of soy beans.

In conclusion the writer recommends caution in the use of these beans as a fodder, until their merits have been more firmly established. Tentative feeding experiments should therefore first be tried on animals of small value.—(EDITOR.)

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THE July (1914) number of the *Journal of the Jamaica Agricultural Society* has a note on "preserving grain" from which the following extracts are made:—

"In recent years we have always used bi-sulphide of carbon for preserving grain from the attacks of weevils. It has some drawbacks, but is all right, when there are large quantities of grains to be kept and places well equipped with receptacles, such as bins, boxes, or even rooms which can be made *air-tight,* and so that a quantity of bi-sulphide can be purchased at one time; also when there is some one responsible who can look after the treatment of the grain. But bi-sulphide does not suit the average man who may only want to keep comparatively small quantities of grain, is not well equipped with the places to store grain, and who is not likely to secure careful handling of bi-sulphide of carbon which is very inflammable.

"Before we gained knowledge of bi-sulphide of carbon we used naphthalene powder which, though not so suitable for preserving large quantities, is more suitable for small lots of grain,

and is easy to handle. The method of using naphthalene is just the opposite of that employed with bi-sulphide of carbon. The latter is a liquid gas heavier than air and when placed in a little tin on top of the grain in a close place, the gas from it sinks through the grain, killing all animal-life, but, unless used in great strength, does not interfere with the food or growing qualities of the grain. Naphthalene powder, on the other hand, is placed at the bottom of the grain, all that requires to be done is to put a pipe through it ; a bamboo, with the joints punched out so that it becomes a hollow tube, does very well. This is put in a box or barrel before the grain is put in so that it stands up with the grain around it. Naphthalene powder is dropped in this tube so that it goes to the bottom of the grain. Two teaspoonfuls of naphthalene powder will keep the grain in an ordinary flour barrel safe from weevils for about three weeks. The powder gradually evaporates and must be renewed when it is all gone, but evaporation is slow, taking about three weeks. If the grain is lying on the floor of a room where bi-sulphide of carbon cannot be used, naphthalene does fairly well. A hollow pipe and a dose of the naphthalene requires to be put down to every 10 feet square to be effective."—[EDITOR.]

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COMMON SALT AS A POISON FOR STOCK.—THE August (1914) number of the *Agricultural Gazette of New South Wales* contains a note on this subject written by Mr. Guthrie with a view to keep stock-owners and especially poultry-breeders and pig raisers on their guard against the danger of too great an admixture of common salt in the food, as several instances have recently been brought to the notice of the local Department, in which the deaths of poultry and pigs have been traced to this cause. Although a certain amount of salt is a necessary adjunct to the food both of human beings and of animals, certain kinds of animals are adversely affected by it when supplied in excessive quantities. The writer quotes Lander, "Veterinary Toxicology," 1912, in which it is said that in the case of pigs and sheep 4 to 8 oz.

has produced poisoning. In larger quantities it has proved fatal to horses, and even to cattle. Fowls would appear to be particularly susceptible. Suffran in his experiments with fowls has found that 4 grammes per kilo body-weight are fatal if injected in solution into the crop. The toxic effect of salt is reported to be apparently due to its action on the muscles, so that the animal becomes unable to walk and finally, to stand. Death is caused by asphyxia, due to loss of power in the respiratory muscles. It is therefore necessary to be cautious in this matter.—[EDITOR.]

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The Agricultural Journal of Egypt, Vol. IV, Part I, has a short article on an experiment with the transplantation of rice on the Indian system conducted at Deirut (Rosetta). The experiment was carried out very carefully on 2 acres of land which was divided into equal plots, the object being to establish a comparison between the Egyptian system of broad-casting rice and the system of transplantation which not only gives an increased yield in India, but also by thickening and shortening the straw renders the crop less likely to be laid by wind. In Egypt while the cost of transplanting was higher as is the case in this country also, the yield on the other hand was only 55 maunds as against 81 maunds from the broadcasted plot. One advantage of the transplanting system found in Egypt was that it enabled an extra cut of berseem, valued at Rs. 33-13-0 to be taken from the unplanted field while the seedlings were in the nursery. But compared with the extra cost (about Rs. 10) of transplanting and the lower yield (a difference of 26 maunds—Rs. 109-13-0), this advantage is very small and it is reported that it does not appear to warrant the substitution of the Indian for the local system of planting in Egypt.—[EDITOR.]

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The Journal of the Board of Agriculture, London (June, 1914), sums up as follows the facts in regard to the duration of the action

of manures investigated at Rothamsted, the particulars of these experiments having been published by Mr. A. D. Hall, M.A., F.R.A.S., in the *Journal of the Royal Agricultural Society* :—As regards farmyard manure, the nitrogenous compounds introduced by the consumption of cakes and other concentrated feeding-stuffs have to be distinguished from the compounds derived from the straw and the undigested residues of such coarse foods as hay. The former will have an immediate effect on the first crop and to a much smaller extent on the second crop, after which they disappear, the latter compounds act slowly, do not waste, and have a measureable value for many years, though for practical purposes their action after the fourth year may be neglected. Among nitrogenous fertilisers ammonium compounds and nitrate of soda have no perceptible action after the first year. Peruvian guano, rape cake, and similar fertilisers containing proteins, leave very little residue after the first year and none after the second. On the other hand nitrogenous fertilisers of the wool, hair, and bone class are slow-acting and non-wasting, and their effect may be expected to persist for at least four years. Phosphatic fertilisers, even when soluble like superphosphate, do not waste in the soil and their residues continue to be effective until they have been exhausted in the crops.

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MIDLAND AGRICULTURAL AND DAIRY COLLEGE, ENGLAND.—The past two years have seen many changes and much activity in the development of agricultural education in England.

Under the Development Act, the funds at the disposal of the Board of Agriculture have been considerably augmented, and for their distribution a comprehensive scheme has been devised. Under this scheme, Provincial Agricultural Councils are set up ; the Agricultural Colleges, already established, are to be enlarged and strengthened in many respects, and the Board contemplate the formation of Farm Schools in many County areas.

The Regulations of the Board have required, moreover, the formation in each County of a special Agricultural Education Com-

mittee or Sub-Committee, and the appointment of an organizing officer whose business it shall be to organize and supervise all forms of agricultural education.

In this connection we have been favoured with a copy of the Scheme of Agricultural and Horticultural Education issued by the County Council of the parts of Lindsey, Lincolnshire, from which we reproduce the following prospectus of the Midland Agricultural and Dairy College.

The Midland Agricultural and Dairy College is situated at Kingston, in the County of Nottingham, and consists of fully equipped buildings and appliances for giving both theoretical and practical instruction in all branches of Agriculture and Dairying, whilst Horticulture, Apiculture, and Poultry Management are also dealt with, as far as they come within the scope of the ordinary farm.

The College was established by the co-operation of the County Councils of Derbyshire, Leicestershire, Nottinghamshire, and Lindsey Division of Lincolnshire, and is administered by a Governing Body consisting of representatives from these Counties. An annual grant is made by each of the Counties, and also by the Board of Agriculture, towards the cost of the Scheme of Education carried on at, and in connection with, the College.

The College Farms.

The College is built in the centre of its own farm, 176 acres in extent, half of which is under permanent grass and half arable cultivation. Students are taken on to the farm for instruction, and are afforded every opportunity of making themselves acquainted with the system of farming followed and with the management of live-stock generally. Experiments are conducted on the manuring of different farm crops, and on the feeding of farm live-stock.

Since Lady-Day, 1912, another farm of 85 acres, situated at Sutton Bonington, about half an hour's walk from the College, has been acquired. This farm, which has a light gravelly soil, is

admirably suited for experimental work, and it is proposed to utilize it a good deal for this purpose.

Courses at the College.

Terms.

Agriculture.

The Session is divided into three terms :—

I. Term—October to December.
II. Term—January to March.
III. Term—March to May.

Students are thus able to be at home during the summer.

Dairying.

The Teachers' Diploma Course and the Factory Managers' Course is divided into two terms :—

I. Term—October to December.
II. Term—January to July.

Short Courses will be held all the year round.

The courses of instruction comprise :—

(*a*) *Agriculture.*—A course in General Agriculture arranged in three Sessions of 10 weeks each, and carried on from October to May. A second year's course is provided for those desiring to take the National Diploma in Agriculture.

(*b*) *Dairying.*—Courses in all branches of Dairying and Dairy Farming carried on all the year round. (Women Students attending these courses may also receive instruction in cookery.)

(*c*) *Rural Economy.*—Rural Economy courses for Elementary School Teachers carried on during the summer holidays.

(*d*) *Poultry.*—Six or twelve weeks' courses in poultry-keeping.

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(*c*) *Rural Economy.*—Rural Economy courses for Elementary School Teachers carried on during the summer holidays.

(*d*) *Poultry.*—Six or twelve weeks' courses in poultry-keeping.

(*a*) Agriculture.—*One year Course.*

The instruction in this course is given in three terms each of ten weeks' duration, commencing in October, January, and April.

I. TERM.	II. TERM.	III. TERM.
October to December.	January to March.	March to May.
Agriculture-Lectures and Demonstrations.	Agriculture-Lectures and Demonstrations.	Agriculture-Lectures and Demonstrations.
Veterinary Science. Agricultural Chemistry. Laboratory Work. Book-Keeping. Mensuration. Agricultural Engineering and Workshops.	Veterinary Science. Agricultural Chemistry. Laboratory Work. Book-Keeping. Agricultural Engineering and Workshops. Dairying. Entomology. Elementary Botany. Farm Calculations. Agricultural Economics.	Veterinary Science. Agricultural Chemistry. Laboratory Work. Book-Keeping. Agricultural Engineering and Workshops. Botany, Bacteriology. Land Surveying, etc. Dairying. Industries allied to Agriculture.

The work which is taught in its most practical bearing, comprises Agriculture (both lectures and instruction on the farm), Veterinary Science, Book-keeping, Agricultural Chemistry, Wood and Iron Work, repairs to Farm Implements and the testing of Manures, Food-stuffs, Seeds, etc.

This course qualifies for the College Certificate in Agriculture.

Arrangements have been made with the Yorkshire Council for Agricultural Education, whereby students requiring a longer course of instruction than is provided at the Midland Agricultural and Dairy College may go through the three years' course at the University of Leeds.

(*b*) Dairying.

The object of the College is to provide a thoroughly practical course of instruction in dairying, combined with such scientific instruction as is found necessary to explain the principles on which the practice depends. The production of milk, and the causes

influencing such production ; milking, treatment of milk for transit, methods of creaming, separating, butter making, cheese making, with the best methods of packing and marketing, are the subjects taught. The instruction in practical and theoretical cheese making may include any or all of the following varieties of cheeses : the various kinds of English cheese (Cheddar, Stilton, Derby, Leicester, Trent-side, Cheshire, Wensleydale, etc.), and of the foreign varieties (Gorgonzola, Brie, Camembert, Gruyère, Edam, Port du Salut, Pont l' Eveque, etc.). Accurate records of all work done are kept by the students. Students are expected to spend the greater part of the day in the actual practical work.

The instruction in dairying is divided into three classes :—

(1) Short Courses.
(2) Teachers' Diploma Course.
(3) Factory Managers' Course.

(1) *Short Course.*

The course for this class extends over a period of six weeks (except the two courses before Christmas, which are of five weeks' duration), and includes instruction in the following branches :—The composition, properties, production and manipulation of milk, cream, butter, soft and hard cheese (not more than two kinds of the latter should be attempted in the six weeks' course), milk record keeping, milk testing, separating, cream ripening, influence of ferments and bacteria on milk, butter, and cheese ; making up and packing of butter ; the general management and common ailments of dairy stock.

The greater part of the time is spent in practical work in the dairy and in class work in dairying, the remainder of the time being taken up with laboratory work in milk testing and lectures on Veterinary Surgery, chemistry of milk and its products. In the Six Weeks' Course one week's practical instruction is in cooking.

A Certificate is granted if the work has been satisfactorily performed and the examination passed.

Practical Dairying each morning throughout the course.

(2) *Teachers' Diploma Course.*

Students entering this course must attend for a period of not less than nine months, commencing in October, if they wish to obtain the Teachers' Diploma granted by the College.

(3) *Factory Managers' Course.*

Is intended for those requiring a commercial knowledge of Dairying or Factory management, such as Dairying in a large way of business, Factory managers, and intending colonists.

POULTRY-KEEPING.

One special course of instruction in Poultry-keeping is held in each year, for those desiring to gain a thorough knowledge of all branches of the subject, and to prepare themselves for the examination for the College Certificate in Poultry-keeping.

The course is of twelve consecutive weeks' duration, and commences at the same time as the third Agricultural term (April).

FEES FOR INSTRUCTION.

Dairy Courses.—For students residing in Lindsey.

10/- per week up to 12 weeks.

9/- per week for each week over 12 up to 18 weeks.

7/6- per week for each week over 18 weeks.

Poultry Course.—Same as for Dairy courses.

Agricultural Courses.—£5 per term of 10 weeks.

Board and Lodging as follows :—

Men, 15/- per week ; Women, 12/- per week.

Washing not included.

Free scholarships and studentships for all courses are awarded.

REVIEWS

The Controlling Influence of Carbon Dioxide in the Maturation, Dormancy, and Germination of Seeds.—PARTS I & II. FRANKLIN KIDD. *Proc. Roy. Soc.*, B. Vol. 87, 1914.

THE delayed germination of seeds is a well-known phenomenon and cases abound in the literature on agricultural subjects. The causes of this latent condition have, however, remained obscure until the paper under review appeared during the present year. The author has shown that the presence of carbon dioxide in the embryo itself is the main cause of delayed germination in resting seeds and he sums up his final conclusions as follows :—

"(1) The resting stage of the moist seed is primarily a phase of narcosis induced by the action of carbon dioxide.

(2) Both the arrested development in the case of the moist maturing seed on the plant, and the widely occurring phenomenon of delayed germination in the case of the moist resting seed, which does not germinate although in apparently suitable conditions of temperature, moisture, and oxygen supply, are related to an inhibitory partial pressure of carbon dioxide in the tissues of the embryo.

(3) Germination when it takes place is related to a lowering of the value of this inhibitory partial pressure of carbon dioxide in the tissues.

(4) The inhibitory value of a given carbon dioxide pressure diminishes with a rise of temperature.

(5) The inhibitory value of a given carbon dioxide pressure diminishes with a rise of oxygen pressure."

During the progress of this investigation, two interesting points of agricultural interest were dealt with. In the case of seeds of white mustard, planted in soil at various depths over decaying grass, it was found that germination was entirely inhibited due to

the high percentage of carbon dioxide in the soil gases. The author suggests that these results show that caution is necessary in placing seed in the ground into which green crops have been ploughed or which has been recently heavily manured. Two instances of poor germination after green-manuring occurred at Pusa in 1913, when seed was sown soon after a green crop of *sanai* (*Crotalaria juncea*, L.) was ploughed in. In one case, a portion of a tobacco nursery was green-manured on July 15th, the tobacco seed being sown on August 19th, thirty-five days afterwards. The germination was exceedingly poor in comparison with normally treated areas and this portion of the nursery practically failed. In the second case, Java indigo was sown thirty-three days after *sanai* was ploughed in, with the result that the crop was very thin in comparison with the control plot.

The second point of direct agricultural interest, referred to in this paper, relates to the seeds of Para rubber which, as is well known, rapidly lose their germinating power. In planting this seed under estate conditions, it is always desirable to put the seed in the ground within a fortnight. On this account, some practicable method of extending the life of these seeds is most desirable. The author found that sealing up the seeds with air in flasks gave far better results than the commercial method now in use of packing these seeds in a mixture of charcoal and ashes. He suggests that sealing up the seeds with the proper proportion of air in large carboys might be tried in practice as by this means the partial pressure of carbon dioxide, which was found to inhibit deterioration in the experiments, could be employed as a preservative agent.

From the point of view of Indian agriculture, Mr. Kidd's investigations suggest a line of work in connection with green-manuring which is almost bound to yield useful results. Experiments on this subject at Pusa[1] show conclusively that green-manuring for cold season crops only gives positive results on light, well-drained soils when the interval between ploughing in the green manure and planting the next crop is about eight weeks. On heavy lands or on lands which are waterlogged from any cause,

[1] *Agr. Jour. of India*, Vol. VII, 1912, p. 79; and Vol. IX, 1914, p. 197.

green-manuring leads to a smaller crop than that on control plots. Shortening the time between ploughing in the green manure and planting the next crop gives reduced yields similar to those on heavy or waterlogged land. That these results are, in all probability, connected with the supply of oxygen in the soil is suggested by the effects obtained last year at Pusa in subsoiling after green-manuring. Three plots were green-manured with *sanai* on July 15th, August 8th, and August 28th, respectively. On September 24th, a strip down the middle of these plots was subsoiled to a depth of about twelve inches, two days before the tobacco was transplanted. The arrangement of the plots is shown in the following diagram :—

Green-Manuring Experiments at Pusa in 1913.

PLOT 1.	PLOT 2.	PLOT 3.
SHADED STRIP	SUBSOILED ON	SEPTEMBER 24th
GREEN-MANURED JULY. 15th	GREEN-MANURED AUG. 8th	GREEN-MANURED AUG 28th

The results of the experiment were very striking. The tobacco in plot 1 grew very rapidly from the beginning and gave the best results. Plot 2 was not so good while plot 3 was poor. In plots 2 and 3 particularly, subsoiling gave a considerable crop increase and the appearance of the tobacco on this strip suggested a liberal dressing of nitrogenous manure. The subsoiling would have released a portion of the carbon dioxide in the soil which had accumulated as a result of the green-manuring and would also have directly increased the supply of oxygen. Possibly the extra air supply not only influenced the final stages in the nitrification of the decaying organic matter but also increased the supply of air for the roots of the tobacco crop. The changes in the soil gases following green-manuring under Indian conditions obviously require to be investigated and the results are almost certain to prove of interest. Besides the time factor, it is exceedingly probable that thorough cultivation after

the green crop has for the most part disappeared will be necessary if optimum results are to be obtained. The large amount of carbon dioxide resulting from the decay of the green crop will probably have to be got rid of and as much oxygen as possible introduced into the soil before the next crop is sown. Field experiments on this point are now in progress in the Botanical area at Pusa.—(A. H.)

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Present state of the Dairying Industry in Bombay.—By J. B. Knight, M.Sc., Professor of Agriculture, and E. W. Horn, Manager, Government Civil Dairy. Bulletin No. 56 of the Department of Agriculture, Bombay. Price 3 annas or 3 pence.

This bulletin deals concisely with the dairy industry in Bombay as it stands at present and gives an idea of what may be done to make much needed improvements in every direction.

The milch cows of the Presidency together with the four types of buffalo chiefly used are reviewed and criticized, and "grading" is advocated as the best method of improvement; selection from local stock being regarded as best left to local breeders, on account of the length of time required to produce any improvement. The authors favour the introduction of bulls of considerable value and deprecate the present method of importing moderate bulls. They however pass too lightly over the risk of disease, taking into consideration the difference between a price of Rs. 6,000 and one of Rs. 600, when one loses an imported bull at the end of 3 months in the country, and, as there can be little doubt but that most of the English 'Dairy' breeds are considerably more liable to disease than the dual purpose animal, it would seem that this question waits on the Veterinary Department for a satisfactory solution. The questions of feeding and housing are dealt with, both of which problems are at present governed by the fact that an enormous number of cows are required to produce as much milk in India as a vastly smaller number would give in England and by the number of "wasters" who fail to "pull their weight" in the herd, but must be kept on because the supply of good cows is getting smaller every year. It is only to be expected that "Suburban

Dairy Farming" with its attendant evils, which has made, and is making, such appalling drains on the best milch cattle of England, is in full swing in Bombay, and it would seem out here that if it is allowed to go on it will effectually counteract any attempts to improve the milch cattle or to lower the price of milk, as it has begun at an infinitely earlier stage than it did in England.

The bulletin after dealing with separating stations and creameries and other works of national importance ends up with an exhortation for cleanliness all along the line, which might with advantage have come first on the principle that it is useless washing your hands after you have milked the cow.

In conclusion one is left with the impression that the milk problem is about to be solved in several ways, but in which way it will be, depends on (1) whether the Veterinary Department stamps out disease; (2) whether the breeder selects up the local stock; (3) whether the agriculturist settles the fodder problem. The first of these three to complete his task will solve the milk question along his own lines of work.—(W. S.)

PLATE VI.

A FIELD CROP OF ONE OF THE CROSS-BRED RACES REFERRED TO UNDER (4)

THE BREEDING OF IMPROVED COTTONS IN THE UNITED PROVINCES.

BY

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In two previous publications[1] the writer has, in collaboration with Dr. Parr, attempted to indicate the lines along which the improvement of the indigenous cottons of the United Provinces has been, and is being, developed. In these emphasis was laid on the results which were at the time bearing practical fruit, and the more detailed work which the writer has been carrying out for a series of years was only dealt with in the briefest outline. In the succeeding pages an attempt will be made to show, in greater detail, both the nature of this latter work and the manner in which the economic aim, that of evolving a plant capable of extended culture in the United Provinces and which will yield a higher money return to the cultivator than that at present cultivated, is being kept in view.

"Failure is less frequently attributable to either insufficiency of means or impatience of labour than to a confused understanding of the thing actually to be done."[2] This statement is applicable to lines of study other than art, of which it was originally written, and nowhere is its truth more valid than in attempts, like the present, to attain practical results through the medium of theoretical considerations. We must "know what we have to do and do it"—in other

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1 *Agricultural Journal of India*, VI (1911), p. 1; and VIII (1913), p. 47.

2 Ruskin. "The Seven Lamps of Architecture."

words, we must in the present case visualise the ideal plant, and, from the material to hand, in the shape of the various forms at present cultivated, set out to produce it. Thus only will success, if it be possible at all, be attained. The first consideration, then, is to picture, in as great detail as possible, the "ideal plant"—that type of plant which is most suitable for cultivation in these provinces. What that type is, is so intimately bound up with the economic and climatic conditions under which cotton cultivation is conducted that the writer may be pardoned for re-iterating what has already been outlined in the two papers referred to.

In the first place, the plant must be early maturing since the marked cold weather, prevalent in the cotton growing tracts in these provinces, is sufficiently intense not only to check growth but to cut back the plant. Thus a definite ultimate time limit is set to the period of growth. An equally sharp initial time limit for fruit production is set by the rainy season, before the end of which no cotton of commercial value is produced. The season of cotton production is, therefore, sharply demarcated, and an early maturing plant alone satisfies these conditions. Such are the limits imposed by climatic conditions.

We may now consider the economic conditions. These are more complex and will require more detailed consideration. The ultimate factor controlling the cotton production is the money return from a unit area of land under the crop. The cultivator is free to choose what crop he will grow, and will devote the balance of his land, after he has provided for the needs of himself, his family and his cattle, to that crop which appeals to him as most remunerative, subject to such limitations as are involved in the maintenance of the customary systems of rotation, which involve a distribution of land between *rabi* and *kharif* crops. Such considerations are, however, of small interest here. The cultivator has already struck his balance and the resultant of such economic forces is to be found in the area under cotton in each particular tract. The problem is to increase the value of a unit area of cotton as compared with the value of such an unit under the type, or types, now under cultivation.

Such increase may arise from two sources, either outturn may be enhanced—an improvement due to quantity—or the value of the produce may be increased through an improvement due to quality. Still further benefit will be derived from a simultaneous enhancement of both factors. We are here concerned with two distinct aspects. The first of these is purely agricultural, the second involves a knowledge of the markets and their needs. These two aspects may, therefore, be considered independently, and it is proposed to discuss them here only so far as is sufficient to indicate those plant characters which require special attention from the practical aspect.

The consideration of quantity or outturn is, in some measure, complicated by the fact that the cultivator reaps, and disposes of, his produce as *kapas* or seed cotton. The purchaser fixes the price very largely by the amount of *rui*, or lint, which that *kapas* will yield. The price realized by the cultivator is, therefore, controlled by—

(1) The actual yield of *kapas*, and

(2) The percentage of *rui* in the *kapas*—the ginning percentage.

Under the limits imposed by the climatic conditions *kapas* yield is very largely controlled by the habit of the plant. The ginning per cent. is, on the other hand, a character of the plant, unaffected or scarcely affected, by climatic conditions.

Yield may also be affected by the size of the fruit or boll. The number of bolls, which will later be shown to depend very largely on the habit, being constant, it clearly follows that the larger the boll, the greater will be the yield. Our consideration of the agricultural aspect, therefore, indicates three points which must be borne in mind in the evolution of the ideal plant. These are—

(*a*) Habit.

(*b*) Ginning percentage.

(*c*) Size of boll.

The question of quality is still more complex—a complexity due partly to the fact that the markets are highly organized and fluctuating. Moreover, they are, to a large extent, independent and

do not always move sympathetically. Broadly speaking, they may be divided into two—the one, centralized in Lancashire, using long staple cottons, the other, including the Continent and the East, chiefly requiring cottons of short staple. The chief source of long staple cotton is Egypt and America and of the short staple India and the East generally. The source of supply being thus widely separated, it is not surprising that we find a year of shortage, and consequently high price, in the one is sometimes a year of full supply and low prices in the other. Consequently conditions can easily be imagined when the inferior, may be a more remunerative crop than the superior, quality. Such cases are, however, exceptional. The cultivator has to look to the main chance and in the average the better the quality, the greater will be the value.

When, however, we come to consider the meaning of the term quality we are faced with considerable difficulty. The trade is highly technical with a terminology of its own. The terms are ill defined and for their thorough understanding a long apprenticeship would be required. Nevertheless certain features are outstanding and these may be shortly detailed.

Broadly speaking, the degrees in quality are determined by the fineness of the thread that can be spun, though here again we have to distinguish between two types of thread—the warp and the weft. For the production of a fine thread certain essentials are necessary. In the first place, we may cite length, for, the longer the individual fibre, the less will be the chance of several ends occurring at a particular spot in the thread and of the formation of a point of weakness where breakage of the thread is likely to occur. Length of fibre will help to an even distribution of strain. For a thread to break, however, it is not necessary that the individual fibres should rupture. Rupture of a thread probably is rarely initiated in this way. Most frequently it results from the drawing apart of interlocking fibres. In other words, the strength of a thread at any point is not given by the sum of the breaking strains of the individual fibres of which it is composed at that point ; it is considerably less than this figure. Two points emerge from this consideration. The first of these is the nature

of the force which binds the fibres together. The process of spinning consists firstly of rendering the fibres parallel and then twisting them to form a thread. The retention of that twist, however, is due largely to the natural twist of each individual fibre, which causes these to interlock—such natural twist is, therefore, a matter of the utmost importance. Secondly, it is clear that the larger the number of the interlocking fibres, the greater will be the force required to pull them apart, or, given the diameter of the thread, its strength at any point will, within limits, increase with the number of fibres of which it is composed at that point. Fineness of fibre is, therefore, a point of much importance.

The three main qualities, which, from the consumer's aspect, have to be taken into account are—

(*d*) Length of fibre,
(*e*) Twist of fibre,
(*f*) Fineness of fibre.

Further points, from the spinner's point of view, are of importance, though this importance is secondary from the aspect of the plant breeder. Here only three may be mentioned—

(*g*) Colour,
(*h*) Uniformity,
(*i*) Nep.

Our ideal plant may, therefore, be defined as one which possesses, as its more important characters, an early maturing habit ; a profusion of large bolls ; a high ginning percent ; a long, fine, uniform fibre possessing a good natural twist ; a good colour and freedom from nep. The production of such a plant, or plants, is the ultimate aim of the work which has now been in progress for some years and an attempt will here be made to show, not only the degree of success which has been obtained in approaching this ideal, but also the evidence there is that such a plant is obtainable—for it is conceivable that some pair of these desirable characters might be mutually exclusive. What is meant by two characters being mutually exclusive can best be illustrated by a reference to the generally accepted idea that length of staple in some way is associated with the growing period of the plant. This idea has found

tentative expression in a recent publication[1] where the following remark occurs: "Length of staple appears to be connected in some way with length of growing season—at any rate no long-stapled cotton has yet come into general cultivation in any district where the normal development of the plant is interfered with by cold at one end of the season and excessive heat and drought at the other. It is probable, however, that this is a coincidence, and that it may eventually be possible to combine earliness and length of staple with a fine yielding power in one plant." In this connection we have first to consider what is meant by the terms "long" and "short" staple. At one extreme of the cottons of commerce lies the Sea Island Cotton with a staple of over 2 in.; at the other lie the inferior Bengals, with a staple of about $\frac{1}{2}$ inch. Between these extremes lie a number of forms, giving an almost complete gradation, and the delimitation of short and long-stapled forms becomes largely a matter of personal choice for which no hard-and-fast definition exists. Practically, however, such a delimitation can be given. Reference has already been made to the Lancashire markets as long staple and to the Continental and Eastern markets as short. Broadly speaking, this distinction holds and the question, therefore, resolves itself into one of the possibility of producing an early maturing plant having a staple at least equal to middling Americans, which we may accept as the standard of the Lancashire market. The answer to this, and similar questions as to linkage between different characters will be given later, after fuller information concerning the characters concerned has been acquired.

(*a*) *Habit.*—As has been stated above, the ideal plant must be early maturing or the yield will be low. The dependence of the length of the vegetative period on the type of branching has, on so many previous occasions, been indicated that this point need not be laboured here. Briefly, the main stem of the cotton plant produces two types of branches—the vegetative and the reproductive. The initial branches, those nearest the ground, are almost invariably vegetative while, higher up the stem, this type of branching

[1] *Report on the Progress of Agriculture in India,* 1912-13.

may give place to reproductive branches. Clearly, the sooner such replacement takes place, the earlier will the plant begin to bear flowers. The type of branching is a point of primary importance in the consideration of habit. Unfortunately, for simplicity's sake, it is not the only point. Certain types of plant occur in which only a small number of vegetative branches arise at the base; above these, branches of the reproductive type are produced but these remain small, and, if buds are produced on them, these buds do not develop into mature fruits. The vigour of the plant is absorbed by the main stem and the few vegetative branches which become long and woody. Such a type cannot produce a commercial crop, and we have to take into consideration a second point, namely, the direction in which the vigour of the plant is diverted. The ideal habit for a plant is one in which the lower branches are vegetative and of moderate growth while the upper are reproductive and vigorous.

(*b*) *Ginning percent.*—The ginning percent of the cottons under general cultivation varies from 30—33 and this figure may be accepted as the standard in considering the question of improvement. During the past few years Dr. Parr has isolated a type of cotton, whose cultivation has spread rapidly in the western districts of these provinces, of which the ginning percent is 40—41, and for the *kapas* of this the cultivator receives a relatively enhanced price, a fact which has to be taken into consideration in deciding whether a new form is a sufficient improvement to justify introduction to the public. The direct relation existing between the ginning percent and the price realized by the cultivator for his *kapas* lends additional import to this figure, and the question of ginning percent has received on this account much detailed attention. The problem is no simple one, but sufficient has been learnt to render it probable that the production of a plant showing a high figure for the ginning percent will no longer be the purely speculative matter it has hitherto been. It is not posssible to go into details here; those that desire fuller information on this subject may refer to the present writer's paper dealing with this point[1]. Briefly, it has been shown that the ginning

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1 *Journal of Genetics*, IV (1914), p. 4!

percent depends mainly on the number of fibres arising from a single seed and, to a lesser degree, on the size of the seed and weight of the individual fibres. With this knowledge it is hoped to produce, by suitable combinations, plants with a ginning percent much above the present standard.

(*c*) *Size of boll.*—The size of the boll is very variable as the following figures for the weight of *kapas* from individual bolls indicate. At one extreme lie the types with small bolls with a *kapas* weight of 2 g. or less ; Broach, *nurma* cottons and others. At the other extreme lies *G. cernuum*—the Garo Hill cotton—with a *kapas* weight as much as 5 g. Between these extremes lie the common cottons of cultivation with a *kapas* weight of 2·5 g. to 3 g. Clearly here there is a range sufficient to make a large difference to the crop yield, supposing the number of bolls to remain constant. The size of the boll is, in a large measure, determined by the number of seeds, the smaller bolls having 7 to 8 per cell—21-24 in all, the medium 8-10, and the largest, those of *G. cernuum*, 13 to 15. It must not, however, be thought possible to double the size of the boll without influencing in some measure their number. The physiological processes of the plant set a definite limit to the production of the food material necessary to nourish the developing embryos, a fact which receives practical demonstration in the length of the fruiting season. With the production of the maximum number of bolls the plant is capable of developing, flowering ceases ; consequently the large bolled-forms have a comparatively short season. Nevertheless, it appears probable that reduction in number is not strictly proportional to the increase in size of the fruits, and that considerable advantage will arise from increasing the size of boll not only through the direct increase in yield but in the number of pickings and in the ease of picking a few large, as compared with many small, aggregates.

(*d*) *Length of fibre.*—The determination of this character is a matter of considerable difficulty. The cotton buyer has evolved a practical method which is most efficient in answering his purpose. It is not, however, suited to the plant breeder who has to take into account the differences between plant and plant. The cotton plant

produces fibres throughout a considerable period, 2-3 months, and under most diverse conditions. As the season proceeds, the moist, and hot, conditions change to dry, and cold. It is not surprising, therefore, that considerable differences in length of fibre are found in samples gathered from a single plant at different seasons. It is further demonstrable that the fibre length varies not only from seed to seed in the boll but even from different parts of the same seed.[1] For the purposes of plant breeding measurements must be comparative and the samples, therefore, must be taken so as to eliminate such variations as far as possible.

Such guarded determinations show the length of fibre of Indian cottons varies from 12 mm. to 30 mm. or over.[2]

Of the former length are some of the poorest forms of Bengal cottons. The latter length is approached only in such cottons as Broach, *nurma* and *bani*. Much of the American type of cotton has a staple ranging from 25 mm.—30 mm., so that among the Indian cottons we have the range of fibre length necessary to produce a long staple cotton.

(*e*) *Twist of fibre.*—During the ripening process, after the fruit has opened, the individual fibres lose their moisture, take on a more or less flattened form and become irregularly twisted on their axis in a spiral manner. It is this twist which causes the fibre to grip in the thread. As far as the writer has been able to observe, none of the cottons with which we are concerned suffer from lack of twist—probably the danger lies rather in the presence of an excess.

(*f*) *Fineness of fibre.*—A large range of variation in this character is found in the Indian cottons, and here, again, the chief difficulty has been met in obtaining a practical method for measuring "fineness." The common methods of direct measurement of breadth are unsatisfactory for the fibre is not, in the first place, round, and in the second place, sufficient determinations to obtain a true average

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1 Yves Henri. *Determination de la valeur commerciale des fibres du cotton.*

2 A mm. standard here is purposely adopted in preference to an inch standard. The measurements are comparative only, and it does not necessarily follow that 25 mm. (1 in.) fibre length would give a sample which commercial determination would denote as of 1 in. staple.

would be beyond practical possibility. The figures adopted here indicate the area of cross section of 1,000 fibres. The range of fineness thus determined has been found to vary from 0·5 sq. mm. in the case of coarse Bengals, to 0·13 sq. mm. in the case of *bani* cotton. The latter figure is the same as that found for Upland American cotton while a sample of Egyptian cotton alone, of those tested, proved to be finer, with a figure of 0·12 sq. mm. Thus we have, among the Indian cottons, races which equal the fineness of the Upland American.

(*g*) *Colour.*—There is no better way, in dealing with this somewhat elusive character than to quote the words of Mr. McConnell.[1] "But for the most part colour is chiefly important as an index to quality. The buyer of cotton yarns is suspicious of the quality if the colour is changed, but when once he is satisfied that the quality is right, a new shade, whether lighter or darker, generally becomes as acceptable as the old."

From this it would appear that, though price is undoubetdly paid for colour,[2] it is rather as an indicator of quality than for its intrinsic merit. Being a character that is with difficulty determinable except in bulk samples, it is not possible to breed for colour. Practically, however, little difficulty has been incurred in maintaining a good colour.

(*h*) *Uniformity* or the evenness of staple length. Lack of uniformity, as it is understood commercially, is most commonly due to race mixture in the field. Such lack of uniformity is at once removed by the cultivation of pure races. Such evidence as we have seems to indicate that the uniformity of a pure race is far in advance of that found in any commercial sample. Where it has been detected in our samples it appears to be due to the admixture of successive pickings which the comparatively small areas, and the desire for a bulk sample, rendered necessary. Grown on the commercial scale when the successive pickings would be harvested separately, this cause of lack of uniformity will, in all probability, be found to disappear.

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1 *Textile Mercury*, March 21st, 1914.

2 Leake & Parr. *Agricultural Journal of India*, VIII (1913), p. 47.

(i) "*Nep*," "*Refraction*," *etc.*—Under such terms are included all losses in the process of spinning represented by the difference between the weight of cotton taken and the weight of yarn obtained. Such losses occur at different stages and have a different origin. In the blow room the chief loss is due to the removal of dirt and extraneous matter such as leaf. The extent of loss will depend very largely on the care expended in picking but to a certain degree on the extent to which the boll opens and exposes the cotton. In this character the Indian cottons differ considerably.

The second loss is in the carding process, during which the weak, short and immature fibres are largely removed. There appears to be no evidence to connect this loss with the character of the plant. It is, rather, traceable to external conditions such as poor cultivation, unfavourable climatic conditions, leading to disease, and such causes. As such, it has little bearing on the plant breeding aspect of the question.

So far an attempt has been made to outline the main characteristics that an ideal plant should have, and we may pass on to a consideration of the material available for the production of such a plant.

The bulk of the cotton grown for commerce in the United Provinces comes from a mixture of races which pass under the name of *G. neglectum*. Many of these races have a good habit and in some instances the ginning percent is high. As a body, however, they are characterized by a short and coarse staple which makes their lint suited for the lowest counts only.

Throughout the provinces are to be found in scattered places a few plants of the *nurma* cotton, *G. arboreum*. The lint of this is the best found in the provinces. It is fully 1 inch in length and moderately fine. The plant, however, is totally unsuited for cultivation by its habit, which is perennial, while the ginning percent of the *kapas* is low.

The only other plant found in these provinces is the *radhiya* cotton of the Eastern districts—*G. intermedium*—a plant conspicuous for its lack of every desirable characteristic. The plant does not fruit till the succeeding hot weather, the lint is short to medium while the ginning percent is 15 only.

Passing to the extra provincial cottons, we have, in the central portions of India, the *bani* cotton. This plant has the finest lint of any cotton examined by us and is of good length. The plant is not, however, robust and the yield is light while the ginning percent is low. The disadvantageous, outweigh the good, qualities, and the growth of this plant, in its present form, does not prove remunerative. This is shown by the way in which it is being replaced by a coarse lint plant in the Central Provinces.

In Bombay the Broach cotton is largely cultivated. This, again, is a late flowering plant, useless for cultivation in the United Provinces. It has, further, in crossing, been found to develop considerable sterility and is, therefore, of little use for the purpose of breeding.

Lastly, we may mention the Garo Hill cotton, *G. cernuum.* This plant is of a robust and early habit with a high ginning percent and a particularly large boll. The lint, however, is too short and coarse to be spun, except into the coarsest of yarn.

The remaining forms of Indian cottons need not be described here, since they have, for one reason or another, proved unsuitable for breeding purposes.

A comparison of the ideal plant, as already outlined, with any of the above known types will disclose in each case an absence of several desirable features in them, and the breeding problem is to combine the desirable features of these plants into a single individual.

The ideal habit has been found in a single plant only—a variety of the common *desi* plant *G. neglectum.*[1] It is early in maturing and bears vigorous fertile branches in profusion. The lint, however, is little better than that of the *desi* mixture, the ginning percent is practically the same and the boll is small. This plant, pure cultures of which are being distributed under the number K 7 in Bundelkhand, for which its early habit renders it peculiarly suitable, must form the basis of the ideal plant it is desired to obtain.

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[1] This description has been allowed to stand as it has been used by the writer in previous papers. The plant, however, is more probably a variety of *G. indicum.*

PLATE IV.

For ginning percent several sources are available. Among the *desi* types there are pure races giving a ginning percent up to 43 and 44. These are, however, invariably coarse and short in the lint. There is also the Garo Hill cotton with a high ginning percent, above 44.

The size of boll varies much in the different races of *desi* cotton, being comparatively large in some cottons received from Dholpur. The plant *par excellence*, however, as regards this character, is the Garo Hill cotton.

Length of fibre may be derived from two sources, the *nurma* or the *bani* cotton. Of these the former plant has been chiefly used owing to its greater robustness.

To obtain a really fine silky lint the use of the *bani* cotton is essential as it is the only cotton possessing this character in full development—the best samples of this cotton being as fine as American, both having an area of transverse section of 1,000 fibres of 0·13 *sq. mm.*

If the argument has been followed, it will be seen that the ideal plant can only be built up by combining the best characters of three or even more races. In attempting this, numerous other subsidiary characters have to be taken into consideration, so that the problem is far from simple. It will now be shown how far progress has been made in the effort to reach the ideal plant, and a description will be given of a few of the more important cultures which have been obtained in a pure state and show to a greater or less degree an advance in the direction of the ideal plant.

(1) From a cross between K 7 and *nurma*. The stem is more erect than that of K 7 and therefore the plant has an improved habit. This plant is very fertile. There still remains a certain amount of variability in length of staple and ginning percent which must be eliminated before samples will be available for test in the mills, but the higher grades are far in advance of any now cultivated in the United Provinces and, in some instances, a ginning percent of 37 is attained.

(2) From a cross between a coarse, but high, ginning *desi* and *nurma*. The plant is moderately early flowering but "leggy;"

in other words, the vigour passes into the lower vegetative branches, the upper fruiting branches remaining slightly developed. Owing to this habit the plant can never yield a remunerative crop owing to the small amount of fruit. The lint, however, is long and of medium fineness and is the best of those so far produced in sufficient bulk for a practical test in the mills. The ginning percent is 30—33. The following report, by Messrs. Briscoe & Vernon[1] of the Elgin Mills Company, Cawnpore, refers to this culture.

Report on the working of the K 26 type cotton.

Nett weight of cotton, 167 lbs.

Waste made in Blow room, 4·7 per cent.

Comparative Wrappings of K 26

and American cotton we are now using, being 20 points on to Middling.

Twist Yarn from Rings.

K. 26		American.	
Wrappings.	Test.	Wrappings.	Test.
24-39 counts	53 lbs.	23·26	53 lbs.

Weft Yarn on Mules.

37-03 counts	26 lbs.	37·00 counts.	30 lbs.

General Remarks.

Note.—These wrappings and tests were taken about 10 A.M. on the 14th May 1914 which was a comparatively hot and dry day and, therefore, not conducive to getting a good test. I consider that if the tests had been taken in February we should have had at least 10 per cent. higher results especially as regards the fine weft yarns. The machines which the cotton passed through were exactly as in former tests, being all new and in very good order. In the warp yarn we should have run it with at least 5 per cent. less twist which means of course increased production and a better yarn. I judged the cotton from a spinner's point of view on the following :—

1*st.*—Length and uniformity of fibre.

[1] The writer takes this opportunity of expressing his great indebtedness to these gentlemen for the tests they have carried out and the reports they have supplied on these new cottons.

PLATE V.

A FIELD CROP OF CROSS-BRED RACE I.

2nd.—Fineness of fibre.

3rd.—Natural twist.

4th.—Strength and elasticity.

5th.—Colour.

6th.—Freedom from impurities (broken seed, leaf, nep).

1st.—The length was 1/8″ over our American. Uniformity excellent, in fact we have never come across a better cotton in India.

2nd.—This is coarser than American and even Purbhani or Barsi which we use as warp cottons, this feature shows against it in the 36's weft, because the finer the counts, the less the number of fibres in the cross section of the thread.

3rd & 4th.—These it possesses in a marked degree 10 to 12 per cent. over our American. These are points which stamp it as an extra good warp cotton up to 24's.

5th.—Colour. An extra pure white cotton which shows up well against American and fits it especially for cloths which need bleaching or dyeing.

6th.—The refraction shows that these are almost *nil.* Freedom from nep was a special feature. Natural and artificial nep are always what we expect to find in all Indian cottons. It is a most serious fault because even the cards do not take it all out. It carries forward and shows in the finished thread as a thick soft place, always a weak spot. Neppy yarn is of course absolutely unfit for warp and as weft it shows up on surface of cloth and even in after processes of dyeing is the cause of the cloth not taking up the dye equally.

The above are the chief points in good cotton which render it fitted for the production of a commercial thread and with exception of No. 2, K 26 possesses them all.

(Sd.) W. VERNON.

(3) This culture is very similar to the latter but is derived from a cross between *nurma* and *bani*. Owing to its habit and low ginning percent (26-30) it can never produce a remunerative field crop and owing to the exigencies of space, it has never been grown in sufficient quantity to yield a practical test. It possesses, however, the silkiness of the *bani* cotton and is, without question, the finest cotton so far produced.

The above three races have all red foliage and a red, or pink, flower.

(4) From a cross between *nurma* and a white flowered *desi* a series of forms are now being grown which are not to be distinguished from the ordinary *desi* plant until the fruit opens when the quality of the lint shows their superiority. These are now under comparative trial at Aligarh and at other farms in the cotton tracts.

(5) From a cross between a *desi* cotton and the Garo Hill cotton. This is a fertile plant with large bolls and a ginning percent which touches 47. The lint, however, is coarse.

The above descriptions briefly outline the races of cottons which have been established in a state of purity. It will be at once recognized that in no case do they fit in fully with our preconceived notion of the ideal plant. Another feature of these races is that they are in each case the direct result of a single cross and, from what has been said above, it was not to be expected that the ideal plant would be thus directly obtainable. We are here faced with the time factor; the selection and the extraction in pure form of desirable races from the progeny of such divergent plants as the above is a matter of several generations and, though the work of re-crossing among these purified forms is now well advanced and in some cases has reached the third generation, a further period will be required before pure races containing more than two original types in their parentage will be available for extended sowing. This may, perhaps, be illustrated by a single instance. There is now the third generation of a cross between races 1 and 3 as described above. These plants contain in their parentage the *nurma*, *bani* and Type 7 cottons, and it is confidently hoped to select from these

a plant bearing a considerable degree of approximation to the ideal plant. This instance, further, will emphasize the necessity of "knowing what we have to do." Race 3 in itself is of no economic value and would, on this consideration alone, be at once discarded. It possesses, however, the combination of fine lint on a robust plant such as is found nowhere else. Its value as a means to an end is, consequently, considerable.

So far in this article attention has been confined to those points which have direct bearing on the quality and quantity of lint produced. Subsidiary points also require brief consideration. The writer has elsewhere referred to the advantage of a characteristic colour in the foliage of any new form by means of which the detection of mixtures and crosses would be much simplified. It is partly for this reason that the *nurma* plant has so largely entered into the crosses made. The lint, however, is not the only produce of the cotton plant which is of value. The seed has a value both as a source of oil and as a cattle food. It has so far been impossible to consider the question of oil content—breeding for such characters is, as yet, in its infancy, and the problem is sufficiently complex without taking into consideration additional factors. As a cattle food, however,—whether directly or indirectly in the form of cake,—the value of the Indian cotton seed is largely depreciated by the coarse fuzz remaining on the outside of the seed after the lint has been removed. Such a fuzz, though present in all the Indian forms of cotton, is not invariably present, and naked seeded forms, both of Egyptian and American cottons, are well known. These forms will not hybridize with the Indian races. Recently, however, among certain cottons received from China, some plants have been found which are naked seeded and completely fertile when crossed with *desi* forms. These all lack the necessary robustness of habit ; but by crossing these with the Indian cottons, robust races have already been raised with a naked seed, and their production appears to present no difficulty.

Before concluding, the question of the evidence that exists as to the limits within which improvement is possible may be briefly touched upon. Reference has already been made to the common idea that long staple cotton cannot be combined with an early

maturing habit of plant. It has been shown above that plant habit is not synonymous with early maturity, but is a combination of two characters at least—the type of branching and the vigour of the fruiting branches.

In the second and third races of extracted forms described above, the long staple of the *nurma* plant is found combined with a branching habit which only lacks the character of vigorous growth of the reproductive branches. We have, therefore, in this group obtained the long stapled, early maturing, plant which only lacks one character to make its extended cultivation remunerative.

There seems, thus, no evidence to justify the belief in the mutual repulsion of long staple and early maturing habit. When, however, the two characters, high ginning percent and fineness of fibre, are considered, there do appear to be valid reasons for considering the two characters to be, to a certain extent, mutually exclusive.

For our purpose the problem may be given in its simplest form. It has been stated above that the ginning percent is dependent in part on the weight of 1,000 fibres ; in other words, the highest ginning percent is only obtainable when the weight of 1,000 fibres is a maximum. The weight of a fibre (and hence of 1,000 fibres) is proportional to its volume, which is given by the product of length by the area of cross section. The range of the latter, as we have already seen, is given by the numbers 50 and 12. For a fibre whose cross section is represented by 12 to weigh as much as a fibre with a cross section represented by 50, it is necessary that the length of the former should be over four times that of the latter. In considering the subject of length, it was noted that the limits found in Indian cottons were 12 mm. to just over 30 mm. Hence it will never be possible to make good the loss of weight due to fineness by increase in length. Fine cottons can have only a moderate fibre weight and consequently only a moderate ginning percent. What the limiting figure is it is as yet not possible to say. That it is well above the 25-26 percent of the *bani* cotton is not doubtful ; that it is as high as 36 percent seems possible ; but that it can be as high as 46-47—the highest figures of which the writer has personal record—is not to be supposed.

THE CONTROL OF *KOLEROGA* OF THE ARECA PALM, A DISEASE CAUSED BY *PHYTOPHTHORA OMNIVORA* VAR. *ARECÆ*.*

BY

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Although the mycological workers in India are very few, a considerable number of plant diseases have already been investigated more or less thoroughly. If we turn, however, to the practical application of the knowledge thus gained, we must confess that only in comparatively few instances has the control of plant diseases been carried out methodically and successfully, and still more rarely has it been taken up to any considerable extent by the agriculturists themselves. An account of the work which is being done in Mysore in connection with the disease known as *koleroga* of the areca palm may, therefore, not be entirely without interest.

To understand the nature of the work a short description of the conditions under which it is being carried out seems necessary. The disease is confined to a region in the western part of the State, having an annual rainfall varying roughly from seventy-five to three hundred inches. It comprises a strip about one hundred miles long and from twenty to thirty miles broad along the extreme western edge of the Mysore plateau. This strip is connected on the north and west with an area in North Canara and on the west with one in South Canara, in both of which the disease is prevalent. It is also to be

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* A paper read at the Indian Science Congress held at Madras in January, 1915.

found in South Malabar and Cochin and, as far as it has been possible to ascertain, these are the only regions in India or, for the matter of that, in the world where it occurs.

In the infected region practically the only important crops grown are paddy and areca nut. The paddy occupies the low-lying lands along streams and the lower stretches of innumerable valleys. The slightly higher ground above the paddy lands both in the troughs and on the sides of the valleys is given over to areca nut gardens. These gardens frequently extend for miles in one practically continuous range forming one of the most charming features of the picturesque Mysore *malnad* and furnishing at the same time one of the chief sources of its wealth.

The gardens are for the most part owned and actually cultivated by Havik Brahmins who, although they cannot be said, as a class, to be highly educated, are, with scarcely an exception, literate. They thus form a body of men who can be reached to a considerable extent through the printed page and who are somewhat readier to take up the new and discard the old than are the majority of Indian agriculturists.

Another important feature in the situation is the value of the crop itself and the great havoc that has been done by the disease. A well cultivated areca garden will, in good years, give returns as high as Rs. 500 or 600 per acre, though the average is, of course, much lower than this, and where the disease is virulent the returns may be reduced to practically nothing at all.

It will thus be seen that there are at least some conditions favourable to the introduction of improved methods of controlling the disease, provided these can be made economically practicable. There are at the same time many, what at first appeared almost insurmountable, difficulties. In the first place, the almost incessant rains of the monsoon reaching, in some places, as high as 20 inches in one day make work at that season a matter of the greatest difficulty. Most of the gardens are situated at considerable distances from the main roads and are practically cut off for days and even weeks from the outer world during the season when the disease

is virulent. Lastly, the disease, attacking as it does the bunches of nuts situated at the top of slender trees from 60 to 80 feet high, is one that presents many physical difficulties in the way of its control. In fact it seems highly probable that in no other part of the world has the scientific control of a disease been attempted where the initial difficulties have been so great.

With regard to the method of control introduced, it is that of spraying the bunches with Bordeaux mixture before the disease appears. Considering the abnormally heavy rainfall concentrated in a few months (in some of the areas treated 140 inches of rain have fallen during the one month of July), it was concluded that it would be practically useless to attempt spraying with the Bordeaux mixture as ordinarily applied and a solution of double strength was used. To this was added an adhesive mixture consisting of ordinary colophonium resin dissolved by heating with soda in water. The finished mixture showed adhesive powers which, considering the torrential rains it had to withstand, were remarkable. In most cases one treatment at the beginning of or early in the monsoon has been found sufficient to protect the nuts from the disease till danger of its appearance and spread is over.

The next difficulty to be surmounted was the application of the spray mixture to the bunches. In the first experiments a large barrel sprayer was used. This was mounted on two wheels and to the pump was attached a line of hose sufficiently long to extend to the tops of the trees. The sprayer itself was run along between the rows of trees and a trained climber then ascended with the hose and directed the spray mixture which was pumped up from below. The spraying could be done fairly satisfactorily, but the difficulty of moving the sprayer about in gardens with deep drainage ditches at frequent intervals was very great. Added to this was the difficulty experienced by the climber in holding seventy or eighty feet of hose full of liquid at the top of a very slender tree during the heavy winds of the monsoon. The danger of a serious accident was great and had it occurred during the initial stages of the work it would almost certainly have damned the whole method of treatment in the eyes of the extremely sceptical garden owners.

It was thus found necessary to discard the barrel sprayer and, as ordinary knapsack sprayers, requiring as they do the use of both hands for their manipulation, were quite out of the question, a special type of sprayer had to be procured. A small air pressure sprayer was therefore specially imported for this work. This sprayer, which has been found admirably adapted to the work, holds rather less than one gallon of liquid, a quantity sufficient to spray from eight to fifteen trees. It is very strongly made and free from complicated parts. Sprayers imported six years ago and given very rough usage since are still working satisfactorily. There is, in fact, only one serious drawback to the sprayers and that lies in the fact that they are or were made in Germany. Luckily a large English firm has, within the past two or three months, agreed to take up the manufacture of sprayers similar in every way and at practically the same cost, so that a supply is assured.

The spraying work during the first two years was carried out entirely at the expense of Government. Subsequent to that time sprayers have been lent free of charge to those desiring to have small parts of their garden sprayed as a demonstration measure, but the garden owners have had to bear the expense of material and labour. In connection with this demonstration work another difficulty was experienced. The small permanent staff of the mycological section was quite incapable of dealing with the work on a large scale. It was therefore decided to utilize local men as temporary fieldmen. Where possible these men were obtained from among the families of garden owners themselves and only those were selected who had a good knowledge of local conditions and could read and write the vernacular. These men were first given a course of training in the use of the sprayers and the preparation of the mixture, and were then distributed throughout the affected area, their work being supervised by the permanent staff. This utilization of local men for the work has proved an unqualified success and has allowed a large area to be covered at comparatively small expense. The fieldmen are engaged for the monsoon season only so that the expenses on that score are reduced to a minimum.

After three years of preliminary experimental work, during which the garden owners had ample opportunity of judging at first hand with regard to the efficacy of spraying, it was decided to offer sprayers for sale. Orders were issued to the men engaged in the work not to do any special canvassing as the intention was to ascertain just what effect the demonstrations themselves had had. The results may be said to have been decidedly gratifying as is shown by the following record of sales :—

1912	..	..	31
1913	..	..	36
1914	..	..	110

Still another difficulty had to be met, *viz.*, the procuring of the spray materials. While all the ingredients are locally obtainable the stocks in any one place are small and the prices correspondingly high. The Department had, therefore, to arrange for procuring the various ingredients in large quantities and stocking them in various convenient distribution centres. The work has expanded so rapidly that during the past year over six and a half tons of material were purchased and stocked in these central depôts to supply the demand.

As over one hundred garden owners are now carrying out spraying quite independently of any assistance from the Department, it is impossible to give accurate figures of the total area sprayed, but from the sales of sprayers and spraying materials not far short of six hundred acres must have been sprayed during the past year against less than two hundred acres during the previous year and about one-half an acre six years ago. From this there can be no doubt that large numbers of the garden owners have been convinced of the practical advantages of the treatment. Estimates of the actual saving which is now being effected by the treatment can, of course, be approximate only, but one leading garden owner, and the first man to take up the work on a large scale, has estimated that the spraying of his garden of twelve acres has, during three years, saved him Rs. 4,000. This is at the rate of more than Rs. 100 per acre per year. From this and from other

information it seems certain that the savings during the past year must have approximated Rs. 50,000. It is anticipated that under average conditions of virulence of the disease the saving will rise to about a lakh of rupees in the present year.

But the work has not been confined to demonstration. Experiments on the preparation of the most economical and efficient spray material and more especially the testing of a large number of adhesives have been carried out in a special experimental garden. This garden hitherto leased by Government has now been acquired and becomes a permanent experimental garden where work on the cultivation of the areca nut and the testing of areca nut varieties will be associated with that more especially related to combating the disease.

A large number of adhesives have been tested in this garden. Of these the resin soda mixture has proved decidedly the most satisfactory and has therefore remained the one generally recommended. One of the interesting features of these experiments on adhesives has been a study of their action upon the physical composition of Bordeaux mixture. As is well known Bordeaux mixture is prepared by mixing a solution of copper sulphate of definite strength with a suspension of lime in water. The result of the reaction is the formation of a pale blue precipitate which settles very slowly and it is by the slow solution of this precipitate on the leaves that the fungicidal action of the mixture is produced. The chemical composition of the precipitate apparently varies considerably with different methods of preparation, but as this has formed the subject of special investigation by Pickering and many others, it is unnecessary to touch upon it here.

Undoubtedly, however, the efficacy of the mixture, especially with regard to its adhesive power, depends to a great extent upon the physical composition of the precipitate. The finer and lighter it is the more perfect will be its suspension in the liquid, the evener will be its distribution on the leaves and the greater will be its power of adhesion. This is recognized in all practical directions for the preparation of the mixture which are invariably insistent upon the necessity of either adding the lime to the copper sulphate under constant stirring or of pouring the two simultaneously into

a third vessel. Experiments readily show that with these methods of preparation the precipitate settles much less rapidly than where the copper sulphate is added to the lime.

If we now turn to the mixture as used against the *koleroga* fungus—where what is practically a resin soap is added to give it greater adhesive powers—we find quite a different state of affairs. If the experiment is repeated we find that the mixture prepared by adding copper sulphate to lime settles much more slowly than when lime is added to copper sulphate. The reason for this difference is at present being investigated. It is cited here as an interesting fact which, speaking personally, has not previously been observed, as well as to show the necessity for the utmost care in experimental work with Bordeaux mixture where other ingredients are added.

There remains for discussion only one other phase of the work. So far a description has been given only of the work in connection with keeping the disease under control. This has been effectively done, but the necessity for annual treatment remains, for it is capable of spreading so rapidly that one or two isolated trees bearing infection are capable of infecting a whole garden. The complete stamping out of the disease throughout the whole infested area would be a herculean task which could be accomplished, if at all, only with the fullest co-operation of all the garden owners. However, there are, here and there, in the midst of badly infested tracts, isolated gardens which have remained free from disease and there are also extensive, more or less isolated areas where apparently all the conditions are favourable to the development of the disease but in which it has not yet made its appearance. There is therefore considerable hope that the disease can be stamped out from isolated tracts provided the whole area in the tract is thoroughly treated. That is, if an area well isolated with little or no danger of infection from other gardens is so thoroughly treated that during the whole season not a single nut is attacked, we might expect to find the disease stamped out. However, a study of the fungus shows us that this is by no means certain.

To those not conversant with mycology it may be stated that the fungus causing the disease produces two kinds of reproductive

bodies or spores. The first of these are formed in special egg-shaped organs called sporangia on the surface of the nuts. Under certain favourable conditions these sporangia burst open at the apex liberating large numbers of motile spores which are responsible for the spread of the disease during the monsoon. These spores are carried by the driving spray from one tree to another and thus bring about fresh infections.

These zoospores, however, are unable to withstand the slightest degree of drought and so are entirely unsuited to carrying the fungus over through the dry season. For this purpose resting spores (oospores) are formed which arise as a result of the sexual union of male and female elements. We have not yet been able to ascertain under just what conditions these resting spores germinate, but work done by Hartig on a closely related form in Europe has shown that the oospores may remain dormant for over two years. We thus see that even should the disease be kept in complete check throughout one or even two years, there is danger of some of these oospores still having retained their powers of germination and so being able to cause a fresh outbreak of the disease. In order to be able to stamp out the disease it would, therefore, probably be necessary to keep it from developing in a garden for at least three years and a longer period might even be required.

Experiments with the object of entirely stamping out the disease are now in progress, and in one garden, situated in an area with an annual rainfall of three hundred inches, we have succeeded in preventing the disease from appearing at all for the past three years. During the present year this garden will be left free from treatment and, as it is well isolated, there are strong hopes that the disease will be found to have permanently disappeared. Other experiments of a similar nature have been begun and a total of twenty-two acres of garden are now being treated with this object in view. Should the experiments prove successful an endeavour will be made gradually to extend the area of stamping out operations, but this will be possible on a large scale only if we can obtain the fullest co-operation of the people directly interested. Whether this can be obtained remains a question for the future to solve.

RECENT HISTORY OF THE COTTON IMPROVEMENT WORK IN TINNEVELLY AND RAMNAD DISTRICTS.

BY

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THE history of the recent efforts to improve the cotton crop in the area where "Tinnevelly" cotton is grown, commenced in 1905, and the procedure adopted was that suggested in the Government of India's letter No. 23-9-36 of 16th September 1904.

Letters were addressed to the principal firms interested in the cotton trade in this tract, who were asked to assist the Department by furnishing the names of farmers or villages, who were noted for the quality of their produce. In response to this request the names of many persons and villages were supplied, and officers of this Department were deputed to visit these places, to examine the crops grown and to interview the growers. Many of the persons whose names were given, turned out to be dealers in cotton and not actual growers. However these tours were of considerable value in determining the variety of cotton most favoured in different parts of the tract; and, in general, it was found that in the north of the tract the variety *uppam* (*Gossypium herbaceum*) predominated, while in the south the variety *karunganni* (*Gossypium* sp.) was held most in esteem. Counts were made in the field in all villages visited. In the north from 65 to 90 per cent. of the plants in the field were *uppam* and the rest except for a few having intermediate characters, were *karunganni*. The proportion of this mixture in general changed, until in the south of the tract the proportions were reversed

and 65—90 per cent. of the plants were *karunganni*, while the rest were *uppam*. Only in two or three villages were any pure crops found. These were in the *karunganni* tract in the extreme south.

All through the tract, however, it was noticed that there was no uniformity in the proportion in which these varieties were mixed. One field might contain only 10 per cent. mixture while the adjoining field might contain 30—40 per cent. or even more mixture. The best villages were those which still preferred to hand-gin their *kapas* and only to sell their lint, while the worst were those which sold all their *kapas* and depended on outside dealers for their seed.

It was fairly obvious, however, that there were genuine reasons, among the more intelligent class of *raiyats*, for this variation through the tract in the proportion in which these varieties were mixed. The *uppam*, though later in showing signs of maturity, is an even ripening cotton and the bulk of the crop can be harvested within two months. Thus in the north where the sowing rains are early and where it is possible for the crop to ripen its *kapas* before the hot weather sets in, the *uppam* was preferred to the *karunganni* which, though it commences to ripen sooner, does not ripen evenly. This means that the picking would continue for three or four months and the probabilities are that many of the immature bolls would shed when the hot weather sets in. In the south it is seldom that the crop is sown before the end of October or beginning of November. This means that the harvest is from six weeks to two months later than in the north and that the hot weather may in any season set in before picking commences. The *karunganni* which never has many bolls ripening at the same time would naturally withstand the effects of the hot weather better than the *uppam*, which might be full of young bolls when caught by the hot weather. In the middle of the tract a mixture of about half and half of the two varieties was generally preferred, as it is not possible to foresee which variety the season would suit best. Even in the *uppam* tract a small proportion of *karunganni* was liked, as the more silky quality of the cotton improved generally the appearance of the sample of lint, while in most places in the south a small quantity of *uppam* was generally preferred as it improved the colour of the lint.

The general opinion of spinners who were consulted however was that it was of much more importance in the first place to improve the staple and to leave the question of colour alone and the simplest method of doing this was to obtain uniformity regardless, for the time being, of quality. Hence the first attempts to improve the cotton of this tract were directed at improving the seed supply. Arrangements were made both in the *uppam* and *karunganni* tracts to procure *kapas* as free from mixture as possible. In the north arrangements were made through Messrs. A. & F. Harvey & Co. to purchase *kapas*, obtained from the mid-season pickings of specially chosen crops, at a slightly enhanced rate. The lint was purchased by the firm and the seed by the Department, who also bore extra charges occasioned by the enhanced rate of purchase and by the fact that all *kapas* was hand-ginned. In the south it was possible to make arrangements with private farmers to supply the Department with hand-ginned *karunganni* seed obtained from their own crops. In this way about 76,650 lbs. of fairly pure *uppam* seed and about 29,000 lbs. of *karunganni* seed were obtained. Of this, however, only 22,860 lbs. of *uppam*, sufficient to sow about 2,286 acres and 14,100 lbs. of *karunganni*, sufficient to sow 1,410 acres, were sold as seed. In this distribution attempts were made to enlist the assistance of the District Revenue authorities. The availability of the seeds was notified in the District Gazette and in the village sheets. Forms of application for seed were at the same time distributed to village officers. Applications for seed had to be made through the village headman either to the taluk head-quarters or to the Koilpatti Agricultural Station. The distribution through the Revenue Department signally failed, nor was any record forthcoming at the time when the crops should be inspected as to how the seed was disposed of. Much of it, it afterwards turned out, was distributed to important villagers who could not well refuse to buy, but it was not used for seed and was fed to cattle. The value of the seed thus disposed of was not all finally recovered until July 1908.

Most of the seed which was sold for sowing purposes was supplied from the Koilpatti Agricultural Station, *karunganni* seed being mainly sold in the south and *uppam* in the north. In

spite of the poor sales, what seed was sown gave great satisfaction and was instrumental in forming a large tract of pure *karunganni* in the Ettiyapuram Zemindary.

Mr. C. Benson, who at that time was Deputy Director of Agriculture for the whole of the Madras Presidency and who had orders to carry out similar work in all other cotton-growing tracts of the Presidency, in his report on the results of the work here and elsewhere stated that too much had been attempted.

In the following season somewhat similar arrangements were again made to collect *uppam* seed with the funds still available in the 1905-06 financial year; but by the time orders were received on the proposals it was too late to make similar arrangements for the purchase of *karunganni* seed, which in any case could not have been made within the financial year 1905-06.

While this work had been going on, a considerable amount of useful information was being collected on the Koilpatti Agricultural Station. This agricultural station is situated in the centre of the cotton area, *i.e.*, midway between the *uppam* and *karunganni* tract. Here these two varieties had been grown separately and opinions obtained on the quality of the lint. These were unanimously in favour of the *karunganni* as being longer, finer and stronger than the *uppam*. Many other indigenous varieties collected from other provinces in India had been tested and compared with the Tinnevelly and other Madras varieties. Several exotic cottons of the American Upland type were also tested. These included Cambodia and several of the improved "long-stapled" American Upland varieties. On the conclusions drawn from these trials, Benson was in a position to make very sound recommendations on the expenditure of the funds placed at the disposal of the Government of India by the British Cotton Growing Association. These insisted on the improvement of existing local varieties and the encouragement of such local varieties which were found to be superior in quality and equal if not superior in yield; and to this end an allotment of the British Cotton Growing Association's funds of Rs. 3,000 was made for the purpose of raising seed on a substantial scale of the *karunganni* variety of cotton.

As this sanction was not communicated until the end of September, it was not possible to do anything for the season then about to commence, but fortunately the rains were early and it was possible to arrange for the purchase of pure *karunganni kapas* in the south before the close of the financial year 1906-07.

Of the *uppam* seed collected in 1906 practically all of this appears to have been sold. The bulk of this was sold through the agency of Messrs. A. & F. Harvey & Co. at Virudupatti, who distributed it through their dealers. Only one of these men however kept any record of the persons to whom he sold the seed. The general impression, both here and around Koilpatti, where seed was distributed, was that this was very much superior to "bazaar" seed. It germinated better and more quickly and gave a stronger and more drought-resistant crop. In all about 14,800 lbs. were sold, sufficient to sow some 1,480 acres. It was satisfactory to note also that as a result of the previous year's seed distribution in the Ettiyapuram Zemindary, a tract of pure *karunganni* estimated at over 2,000 acres had been established and that the Zemindary authorities had stored *kapas* for seed which would give sufficient seed to sow nearly 3,000 acres in the following season.

In 1907-08 considerable development commenced in the work of cotton improvement. In the first place, it was found impossible with the staff at the disposal of the Department to attempt to cope with the whole of the tract. Secondly, it was found impossible to try and push two types of cotton. Both the *uppam* and *karunganni* were found to yield on the average practically the same; but the yield obtained varied considerably from year to year, the season sometimes favouring the one and sometimes the other. If in one season *uppam* had yielded better than *karunganni*, then the next year the *raiyats* all favoured *uppam* which would in the following season probably not fare as well as the *karunganni*. Thus, with the impetus given to *karunganni* by the decision to push this variety with the funds placed at the disposal of the Department by the British Cotton Growing Association, it was decided to confine, for the present, the work to the southern half of the tract. In this year about 12,400 lbs. of *karunganni* seed

were collected and sold, there being an eager demand for the same.

Meanwhile on the Koilpatti Agricultural Station considerable knowledge of the cottons of the tract was being obtained, while improvements in the method of cultivation were being tried and, where successful, were adopted. Benson in 1905-06 strongly suspected natural cross-fertilization to be common and selected many plants growing in mixed crops of *karunganni* and *uppam* which he classed as "putative crosses." At the same time he made crosses between *karunganni* and *uppam*, *uppam* and *karunganni* and also obtained fertilized seed of both these varieties by crossing with pollen from other selected plants of their respective varieties. From the former were obtained plants which closely resembled their respective female parents in the first generation except for much greater vigour. These in the second generation split up into all manner of types, many of which were similar to the "putative crosses" marked by Benson. The latter also showed much greater vigour, but in the second generation the two varieties behaved quite differently. The *uppam* showed practically no variation. The plants retained their greater vigour, but practically no variation could be found in the lint or seed or in the habit of the plant. It seems, therefore, evident that the *uppam* is a distinct species. In the case of *karunganni*, however, in the second generation, very considerable differences were noticed in the progeny, both in the habit and in the character of the seed and lint. Hence it is probable that the *karunganni* is not a separate species but merely a cultivated variety. This is further borne out by the fact that Fyson, who examined the crop of the second generation of the crosses between *uppam* and *karunganni*, could not find any characters which followed Mendelian laws.

Several plants of *uppam* × *uppam* and *karunganni* × *karunganni* were selected and grown as unit strains. It was found that the majority of the *karunganni* selections remained true to type both as regards the shape of the plant, the habit, the ripening, the fineness or otherwise of the lint and the percentage of lint to seed. Thus there were possibilities even then of producing strains which in time would prove superior to the ordinary *karunganni* and strains

which would suit not only the seasonal conditions of the south but also those of the *uppam* tract in the north. The selection of *uppam* was subsequently discontinued as it was found impossible to prevent crossing of the two varieties.

In the meantime it was imperative to maintain and if possible improve the ordinary *karunganni* so as to popularize as much as possible the seed which the Department was selling. The *karunganni* crop grown on the Koilpatti Agricultural Station already showed its superiority over that being then distributed by the Department. This improvement had been effected by plant to plant selection, the selection being done entirely by the habit of the plant. In this way a bulk selection was each year made, the crop from which provided sufficient seed to sow the whole area available on the Agricultural Station. Thus in 1908 it was decided to start seed farms in the district where not only the *karunganni* seed, obtained from the crops grown on the Koilpatti Agricultural Station, could be grown but where the system of drill cultivation found so successful on the Agricultural Station could be demonstrated.

An account of this latter work has already been contributed to this journal (Volume IV, page 188), and it is enough to say that the results obtained were eminently successful ; so much so that, whereas in the first year persons who raised seed farms for the Department required much persuasion to agree to do so, in the next year it was possible to pick and choose and thus to select better land. Herein however both the *raiyats* and the Department were too greedy. *Raiyats* who had seen the seed farm crops the previous year, and in most cases no such yield had ever been obtained on those particular lands before, came forward and offered their very best lands as seed farms. These are lands known as "Cumbadi" (Lit., beaten by *cumbu*), *i.e.*, lands which are very heavily manured and on which *cumbu* (*Pennisetum typhoideum*) is grown every year, this being the principal cereal of this tract. The year which followed started favourably and the crops in the initial stages grew and promised well, but as the plant food was near the surface the crops developed a surface root system which could not withstand dry weather conditions

and the crops were unable to ripen properly. The acre yields were in consequence considerably less than in the previous year.

The seed obtained was similarly sold throughout the south, village depôts being located at suitable places throughout the tract. These were placed in charge of some reliable man in the village who was given a commission on sales effected.

Though the area of seed farms was not materially increased, considerable progress was made during this year and the next in popularizing the use of the seed drill and accompanying implements. There were several difficulties in the way, one of the principal being that it was not easy to sow mixtures with the cotton. Pulses, Coriander, *tenai* (*Setaria italica*) are usually mixed in small quantities with cotton when this is sown broadcast, and as these are the perquisite of the women of the household, there were naturally objections to sowing cotton pure. However as greater experience has been obtained in drilling, this objection has largely been overcome, nor is there the same objection to pure cotton as there formerly was as this is found to yield better. Moreover bullock hoeing has considerably lightened the woman's share in the cultivation as formerly she had to take her share in the hand hoeing which the crop received ; and in villages where the people are still dependent on the Department for the loan of implements, it is the women who so to speak enter the fray to get first served with the bullock hoes.

The distribution of *karunganni* seed sufficient to sow each year from 10,000 to 12,000 acres naturally had a considerable effect on the quality of the cotton in the south. New ginning factories were put up by cotton buying firms in this tract mainly on account of the superiority of the crop and these combined with two or three seasons of short crop have done much to undo the Department's efforts to keep the crop pure. In 1912 it was found that what a year or two previously had been practically a pure *karunganni* tract was again a hopeless mixture of "bazaar" seed. Although the fact that ginning factories under proper management do much to maintain the quality of export cotton by having the ginning under proper control, their introduction tells very seriously on the quality of the seed sold for sowing. Village dealers instead of ginning the

village *kapas* by hand and selling the lint, now dispose of the *kapas* to travelling dealers who deal directly through the brokers employed by the factory. Consequently all *kapas* whether good or bad is mixed, bad samples are graded up with good, *kapas* which will not pass muster is similarly graded up till it does. The crops in the neighbourhood of these factories further showed that much of the seed had been brought from a distance, and it is probable that this arrived at the ginning factory by cart, being what was refused by the ginning factories further north on the cotton route. *Kapas* instead of being stored dry, as formerly, is now often collected straight from the field and packed immediately into *borahs*. The result is that much of the cotton heats and the vitality of the seed is either weakened or altogether destroyed.

It looked therefore as if all the Department's efforts to grade up the crop to pure *karunganni* were to be of no avail. The seed supply required for the Tinnevelly District (*i.e.*, the south of this cotton tract) may be roughly estimated at 2,500,000 lbs. This means the produce of 8,000 to 10,000 acres. At the present time the Department supplies from 4—5 per cent. of this. It was obviously impossible for the Department to control such a large area of seed farm nor would it be a wise policy to make the *raiyat* entirely dependent on the Agricultural Department for the seed supply. Further the work on the Koilpatti Agricultural Station in producing suitable unit strains of *karunganni* was now sufficiently advanced for rapid development in the district. It was, however, of no use issuing seed if, when the crop was collected, it was to be sold to dealers and lost sight of. It was decided therefore to restrict the area of departmental seed farms to 400 acres and to try and induce villages, which had purchased our seed, to co-operate and take in to the gins sufficient *kapas* to supply, if not the whole, a considerable portion of the village with seed. It was thought that, if co-operation on these lines could be induced, such villages would be useful for putting out, in the first instance, seed raised from unit strains. With this inducement held out to them, three villages in the 1912-13 season agreed to this step. Accounts were kept which showed that this

procedure was sufficiently remunerative to more than pay for the extra trouble involved.

It may be mentioned that the limited supply of seed stocked by the Department and the keen demand for this seed has been largely utilized as a lever to extend the work of cotton improvement. All the seed sold in 1913 was sold on the understanding that the crops would be sown with the drill and in this way drill cultivation has been extended to many new villages. It is true that all who promise this do not act up to it, but very many of them do and last year more than 7,000 acres of cotton and *cumbu* were sown in this way. In the same way this year in arranging village seed depôts, these have in many cases been located in villages on the understanding that the villagers would co-operate for the joint sale of *kapas* in order to get back their own seed from the ginning factories. Last season twenty villages thus co-operated and seed has been stored in them to sow next season about 12,000 acres. To these villages seed of a unit strain will be sold in the coming season in limited quantities, subject to the condition that the villages will again co-operate in a similar way. These limits are fixed according to the estimated seed requirements of the village in the following year. This means that each such village has to all intents and purposes its own seed farm which it is estimated will supply its requirements in full. The strain which is to be issued to them promises to be a great improvement on what is now being grown. Last year it was grown on 12 acres and yielded 620 lbs. of season *kapas* per acre against an average yield of 454 lbs. for ordinary selected *karunganni*. It gave a ginning outturn of 31·3 per cent. against the district average of 25 per cent. and the spinning tests, kindly made by the Tinnevelly Mills, showed that it was quite suitable for spinning 40's. yarn against 26's. yarn for the ordinary selected *karunganni*.

This year a further extension of this work has been started. As already mentioned *uppam* cotton, though considerably inferior to *karunganni* in quality, is the main variety grown in the north of this tract on account of its even ripening habit, and for this reason work in the past has been confined to the middle and south of the tract

where the qualities of *karunganni* are to some extent known and appreciated. The question of the ripening habit of *karunganni* has, however, received considerable attention and several of the unit strains which are being grown have been selected for their evenness in this respect. These are now sufficiently advanced to put out on to seed farms. Two strains are this year to be grown. One which has a ginning outturn of 27-28 per cent., *i.e.*, 2-3 per cent. above the district average for ordinary dry black cotton soil and spins a very good 50's. The other which has a ginning outturn of 33⅓ per cent. and spins up to 44's. will be grown on a tentative scale in certain villages where much damage is being done to the Tinnevelly cotton by the cultivation of what is known as "Pulichai" or "Mailam" cotton. This is the white flowered *jari* of the United Provinces and it is grown chiefly on lands which can if necessary be irrigated ; for the main reason that it has a ginning outturn of 33 per cent. it is encouraged by dealers, who by mixing it with Tinnevelly cotton, can raise their general ginning outturn.

It may be mentioned in conclusion that the Department have throughout this work received every help from Messrs. A. & F. Harvey & Co., both at Tuticorin and Virudupatti especially from Mr. A. Steel, the agent at the latter place. It is through the agency of this firm that the Department have been able to have their spinning tests made, and it is the only firm dealing in cotton in this tract which has so far been prepared to pay the producer an extra price for quality.

COTTON IMPROVEMENT IN BERAR.

BY

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It is a generally accepted opinion among those who are engaged in introducing improved agriculture in India that there is more scope for improvement in a tract where farming is backward than where it is more advanced. This opinion is not justified by the experience gained in these provinces, and the writer doubts whether it would apply as a rule to India as a whole. The backwardness of the agriculture of a tract is generally due to several factors such as an unfavourable climate, an uncongenial soil or to the want of enterprise among the inhabitants. As a rule, inferior cultivators are found in tracts where the soil or climate or both are bad, because there is less competition there owing to the tendency of the more enlightened to migrate to other parts where the conditions of life are more congenial. It follows, therefore, that as a rule the task of raising the standard of cultivation in a backward tract is an extremely hard one because the soil, the climate and the nature of the inhabitants themselves, all handicap progress. To illustrate what is meant let us compare the *raiyats* of Chhattisgarh in the Central Provinces with those of Berar. In Chhattisgarh the climate is malarious, the outturn of the staple crop, namely, rice, is poor in years of low rainfall owing to the want of facilities for irrigation, and the consequence is that the *raiyat* is poor and unenterprising. Progress in introducing improvements under such conditions must necessarily be very slow. In Berar, on the other hand, the climate is healthy, the staple crop, namely, cotton, is less dependent on the exigencies of the rainfall, the soil is very good, a

failure of the crop is the exception, and the result is that the cultivator is wealthier, more go-ahead and much more advanced in his craft. In a tract of this kind, though the practice of agriculture may have reached a high standard, the conditions are such that still further progress is made easy, for the cultivator is intelligent and readily appreciates the advantages accruing from the adoption of new and better methods of husbandry.

When the Department of Agriculture started operations in Berar about eight years ago by opening an experimental farm near Akola, there were no very obvious lines of improvement which could be seized on. The Berar people cultivated their staple crops, *viz.*, cotton and *juar*, carefully, and had increased in wealth. For all their different varieties of *juar* they had local names and they kept each variety fairly pure ; but for their cottons they had only one name *katilvilayti* or *jari* which terms included a mixture of six distinct varieties which, on being grown separately, were found to vary enormously in yield of *kapas* and in the percentage of lint to seed. With a view to making the cultivation of these two staple crops more profitable, elaborate series of experiments were drawn up which have now been carried out over a period of seven years, and which have given results of the very greatest value. However, this article will restrict itself to a brief description of these results in so far as they apply to cotton.

Of the six varieties of cotton forming the mixture known as *jari* or *katilvilayti*, it has been proved conclusively that *roseum*, a white flowered variety giving 40 per cent. of lint to seed, and a large yield of *kapas*, is easily the most profitable cotton to grow under the soil and climatic conditions which obtain in these provinces. The table below shows the average yields obtained from these cottons over a period of seven years :—

Name of variety.	Average outturn of lint in lbs. per acre, 1907-13.
G. N. malvensis	132
G. N. vera	146
G. N. roseum	204
G. N. roseum cutchicum	190
Berar Jari (previously grown everywhere in Berar)	162
Saugor Jari	156
Bani	97
Buri	121

It is worthy of note that the yield of *roseum* has been about twice as great as that of *bani*, the variety which was being recommended by the Department previous to the opening of the Akola Farm and the experimental work thereon.

By substituting a selected strain of this *roseum* cotton for *jari*, the farm was able last year to increase its profits on cotton cultivation by Rs. 3,940. It was mainly due to this very material improvement that the farm has made such large net profits every year. The profits last year after paying all expenses including the salaries of the staff amounted to Rs. 5,210.

At an early stage of our experimental work it became obvious that the superiority of this variety of cotton was assured and its improvement by plant-to-plant selection was taken in hand in earnest. Of the many strains raised from single mother plants the highest yielder was found to be one which we have registered as *No.* 1 *Roseum.* The quantity of seed of this strain distributed to cultivators for sowing gradually increased year by year, till this year it reached the enormous figure of about two million pounds, and we anticipate that in future it will be possible to increase the distribution by nearly one million pounds a year. The production and distribution of this cotton was effected through private seed farms managed by the owners under the supervision of the Department of Agriculture. To these farms selected *roseum* seed was supplied each year from the Akola Experimental Farm. This seed was in turn propagated and distributed in large quantities to cultivators in adjoining villages. But with the rapid increase in the number of seed farms it became evident that concentration was necessary in order to guarantee more efficient supervision. With the assistance of the Registrar of Co-operative Societies some of these seed farms have, therefore, been converted into the central farms of Co-operative Agricultural Seed Unions. Each Union consists of ten or more members, each of whom guarantees to grow only selected *roseum* cotton and to keep all the seed for distribution.

The number of villages included in the Union may vary from one to ten. Each Union has a central seed farm or farms comprising an area of from 25 to 100 acres to which selected seed is supplied every year from the Akola Farm. The areas sown with *roseum* by the other members of the Union have been designated branch seed farms. The main purpose of the central farm is to supply pure seed to the branch farms, but, when more seed is produced on the central farm than is required for the branch farms of the Union, it is sold as part of the Union stock of seed. It is the duty of the Department to see that only pure selected seed is supplied to the central farm and that only pure seed is handed over to the branch farms; while it is the duty of the Union *kamdar* to see that the seed of the branch farms is kept pure.

For each Union a chairman to preside at their meetings, two supervisors to supervise the field work and a secretary to look after the clerical work of the Union are appointed. Most Unions have appointed a *kamdar* who is a paid worker. He supervises the sowing of all the farms, uproots any alien plants that make their appearance, and looks after the ginning of the *kapas* and the bagging, labelling and distribution of the seed. The only expenditure incurred by most Unions is that of the pay of the *kamdar* which seldom exceeds Rs. 180 per annum. In order to be able to meet such expenditure the members have a Union Fund which they raise among themselves, each paying from 2 to 4 annas per acre of *roseum* cotton grown. The *kapas* of only one Union is ginned on a plant which is the common property of the members. In most cases one of the members has a small ginning plant consisting of two or three gins driven by an oil engine and on this plant he arranges to gin all the *kapas* of the Union at a given rate.

Twenty-two Unions have already been opened of which nine have been registered. The table on the next page gives in a condensed form the profits made by the four Unions which in June last completed a full year's work.

The profits were mainly made on the sale of *roseum* seed. Taking the district as a whole we find that *roseum* seed was sold by Unions

Table showing profits made by the four Unions for year ending 30th June 1914.

Name of Union.	Number of members.	Area in acres under *roseum* cotton.	Quantity of *roseum* seed produced in lbs.	Quantity sold in lbs.	Selling Price.	Receipts for seed.	Cost of same quantity of *jari* seed in bazaar.	Profit on sale of *roseum* seed.	Profit on sale of implements.	Expenditure of Union.	Net profit.
						Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
Gaigaon ..	18	609	65,694	65,694	16 to 20 lbs. per rupee.	3,218 9 0	1,642 6 0	1,576 3 0	*Nil*	138 12 0	1,437 7 0
Paras ..	12	360	40,011	40,011	18 lbs. per rupee.	2,286 5 0	1,000 4 0	1,286 1 0	8 0 0	19 10 0	1,274 7 0
Balapur ..	15	268	21,600	20,360	20 lbs. per rupee.	1,015 13 0	507 14 0	507 15 0	8 0 0	96 0 0	419 15 0
Sonwadhona ..	56	1,441	84,160	81,360	14 to 16 lbs. per rupee.	6,069 12 0	2,184 0 0	3,885 12 0	64 0 0	310 0 0	3,639 12 0

and seed farms at from Rs. 25 to Rs. 46 per *khandi* of 560 lbs. The bazaar rate for ordinary cotton seed was only Rs. 14 per *khandi*. The demand for *roseum* at this price was very great: despite the fact that about two million pounds were produced, more could have been sold had it been available. But the profit from the increased yield of lint, too, must have been considerable, as may be gathered from the summary below, which gives the average yield of *roseum kapas* and percentage of lint obtained by the different Unions and seed farms last year, compared with the district average for the year.

District.	Percentage of lint to seed.		Outturn of roseum compared with the district outturn for the year.	
	Jari.	Roseum.	Jari.	Roseum.
Akola	35·6	39·7	300	345
Buldana	34·95	39·45	301	321
Amraoti	35·57	38·75	290	394
Yeotmal	34·7	39·51	247	340

In addition to these Unions there were 38 cotton seed farms run by private individuals, some of whom will in due time form Unions with the seed farm in each case as the nucleus of the Union.

By starting with seed farms the Department is in a position to select the best material for these Unions; for it is very important that the individual member should be a good co-operator as well as a good cultivator.

By grouping together the villages in this way to form one agricultural unit improvements can be introduced on a large scale with a minimum amount of effort; for the Department deals with the Union as a unit, while the Union in turn controls the affairs of the different members of which it is composed. To reduce the work of the Department still further, Union Inspectors are being appointed who are under the administrative control of the central co-operative credit banks—though working under the advice and supervision of the Department of Agriculture. This will ensure still

closer co-operation between our Department and the official and non-official workers in the co-operative credit movement.

Of the other series of experiments carried out on the Farm the rotation experiment with *roseum* cotton as the principal crop has given most useful information. In this experiment cotton grown in rotation with wheat, *juar*, gram and *tur* is compared with cotton grown in the same plot continuously. Before these experiments were started the whole programme was submitted to two of the highest agricultural authorities in India for criticism. They pointed out that the cultivation of cotton on the same land year after year was unsound, as it would tend to intensify the damage done by insect pests and to impoverish the soil. The table below shows the results obtained in practice :—

Name of crop.	Average net profit per acre from 1907-14. Rs. A. P.
Cotton } Wheat }	29 15 0
Cotton and *tur* } *Juar* }	20 9 0
Cotton } Gram }	25 12 0
Cotton } *Tur* }	30 14 0
Cotton	32 2 0

Taking the average value of the outturns per acre over a period of seven years, we find that cotton grown continuously on the same plot proved to be the most profitable system of cropping, and no bad effects from insect pests or soil exhaustion are yet apparent. Continuous cropping with cotton has also been practised in part of the non-experimental area of the Farm with the same good results. Still it is too early yet to recommend it as a general practice to be followed ; for there is in Berar a considerable area of land infested with cotton wilt and there is some reason to believe that its prevalence in certain villages is due to the too frequent cropping of the same fields with cotton.

Another experiment which has given results which are contrary to what was anticipated is that designed to ascertain the advantages

of topping cotton plants when about one foot high in order to stimulate branching. This practice had previously been recommended by the Department to cotton growers though it had never been tested experimentally. The results are given below :—

	Average outturn of *kapas* in lbs. from 1907-13.
Topped	480
Not topped	523
Duplicate.	
Topped	330
Not topped	373

Topping involves considerable expenditure and reduces the yield. It also retards the time of maturing. Needless to say "topping" of cotton plants has been given up on the strength of these results.

The best spacing distance for cotton plants has also received attention. This was all the more necessary as previous to the opening of the Farm the Department had laid it down as an empirical rule that cotton plants should be thinned out so as to stand at a distance of from 12 to 15 inches apart in the rows. The results for seven years are given below :—

Spacing distance.	Average outturn of *kapas* in lbs. per acre from 1907-13.
Rows 15″ apart and plants 7″ apart in rows ..	520
,, 15″ ,, ,, ,, 15″ ,, ,, ..	503
,, 20″ ,, ,, ,, 15″ ,, ,, ..	517
,, 20″ ,, ,, ,, 20″ ,, ,, ..	396
,, 25″ ,, ,, ,, 20″ ,, ,, ..	395
Unthinned	388

In the first five years of the experiment a spacing distance of 15 inches from row to row and 7 inches from plant to plant in the row gave the highest outturn. As the plot increases in fertility, however, owing to the accumulation of the residues of the manure

applied every year, a wider spacing distance has done equally well. The more fertile soil produces larger plants which require more room. The practice followed by some cultivators of allowing all the plants which come up to mature is a bad one, except in the poorest soils. For soil of medium fertility the spacing followed in Plot No. 1, is probably the best: in comparatively rich soil yielding from five to six hundred pounds of *kapas* per acre the spacing distance allowed in Plots 2 and 3, would be equally good.

In Berar land is valuable and the area under grazing has been reduced to its lowest limits; consequently cattle manure is scarce. Experiments were, therefore, designed to ascertain what supplementary manures could be used with most advantage. In one series the manures compared were 64 mds. cattle dung, 64 mds. poudrette and 2 mds. saltpetre. Of these poudrette proved to be by far the most economical.

In a second manurial series nitrate of soda, superphosphate and sulphate of potash were tried singly and in combination, and sulphate of ammonia and calcium nitrate were applied singly. The superphosphate, sulphate of potash and sulphate of ammonia were drilled in at the time of sowing at the rate of 40 lbs. of phosphoric acid and 35 lbs. of potash and 20 lbs. of nitrogen per acre respectively. The nitrate of soda was applied as a top dressing at the rate of 20 lbs. nitrogen per acre. The outturns obtained are given below :—

Manures.	Average outturn of *kapas* in lbs. from 1910-13.
1 Nitrate of soda, Superphosphate, Sulphate of potash	660
2 Nitrate and superphosphate	679
3 Nitrate and potash	563
4 Nitrate alone	496
5 Sulphate of ammonia	469
6 No manure	403
7 Calcium nitrate	491
8 Superphosphate and potash	501
9 Superphosphate	500
10 Sulphate of potash	413

The soil is very responsive to nitrogenous manures. It would appear to be deficient both in nitrogen and phosphates but rich in potash. Acting on these results, nitrate of soda has been stocked for sale on the Akola Farm and about 4 tons of this fertilizer were sold to cotton growers last year; but the purchasers were advised to use it only to supplement a dressing of cattle-dung applied in the same year. If used alone the value of the increase produced will seldom cover the cost of the manure. Moreover, the deteriorating effect which this artificial manure has on the soil would almost certainly prove detrimental to the stiff clayey loam of the cotton tract after a time.

That both nitrate of soda and saltpetre can be applied at a profit to supplement a light dressing of cattle-dung is evident from the results of the series given below, in which the two fertilizers were applied as a top-dressing when the plants were about one foot high :—

Treatment.	Average outturn of *kapas* in lbs. per acre, 1907-13.	Net profit due to manure in 1914-15.
		Rs. A. P.
64 mds. cattle-dung + 10 lbs. nitrogen as nitrate of soda.	649	38 5 0
32 mds. cattle-dung + 20 lbs. nitrogen ..	596	25 8 0
No manure	333	....
64 mds. cattle-dung + 10 lbs. nitrogen as saltpetre.	631	30 0 0
32 mds. cattle-dung + 20 lbs. nitrogen as saltpetre.	565	20 9 0

The application of the fertilizer has in this case always accounted for a considerable acreage profit and has at the same time accelerated the maturing of the cotton to which it was applied. When applied along with the more bulky manure its deteriorating effect on the physical texture of the soil is likely to be neutralized.

But the most useful experiment carried out from the practical point of view was that to determine the manurial value of cattle urine conserved by the dry-earth system, the urine being absorbed by a layer of 6 inches of dry-earth spread in the stalls.

Manure applied per $\frac{1}{10}$th acre.	Average outturn of *kapas* in lbs. per acre for 4 years.	Net profit due to manure in 1914-15.
		Rs. A. P.
Dung and urine of two bullocks for 30 days ..	601	34 9 0
Dung alone of the same animals for 30 days ..	440	17 1 0
No manure	284	....
Their urine alone for 30 days	444	16 0 0

The same manures have been tried for *juar* in which case urine has given an equally good account of itself. It would appear that the manurial value of a bullock's urine conserved in this way for either of the two staple crops of the tract is just about equal in value to that of its solid excreta. This finding has been recommended for general adoption and is being put into practice by many of the leading landowners. Owing to the high prices of cotton during the time these experiments have been under trial, heavy manuring has as a rule been profitable. But few of even the most enterprising cultivators yet realize how highly economical it is to manure their cotton lands with such locally available manures as cattle-dung and poudrette at present prices.

The results already obtained from the different experiments with cotton are of considerable scientific as well as pecuniary value. They have given us a much more accurate knowledge of the different phases of cotton cultivation than ever we possessed before : they have at the same time exposed the error in some of the rule-of-thumb methods commonly followed by cultivators. They have given the Department of Agriculture a foundation on which to build up future improvements. It is difficult to give any idea of the pecuniary value, to the agriculture of the provinces, of the lessons learnt on the Akola Farm, which are now being incorporated into the farming practice of the leading cultivators. Had the price of cotton been normal this year the introduction of *roseum* should have increased the farming profits of our cultivators by at least 10 lakhs of rupees, a sum which far exceeds the total expenditure on the Agricultural and Veterinary Departments.

PLATE VII.

THE NORTH-WEST LOCUST

EXPLANATION OF PLATE.

THE MIGRATORY LOCUST.

Acridium (Schistocerca) peregrinum.

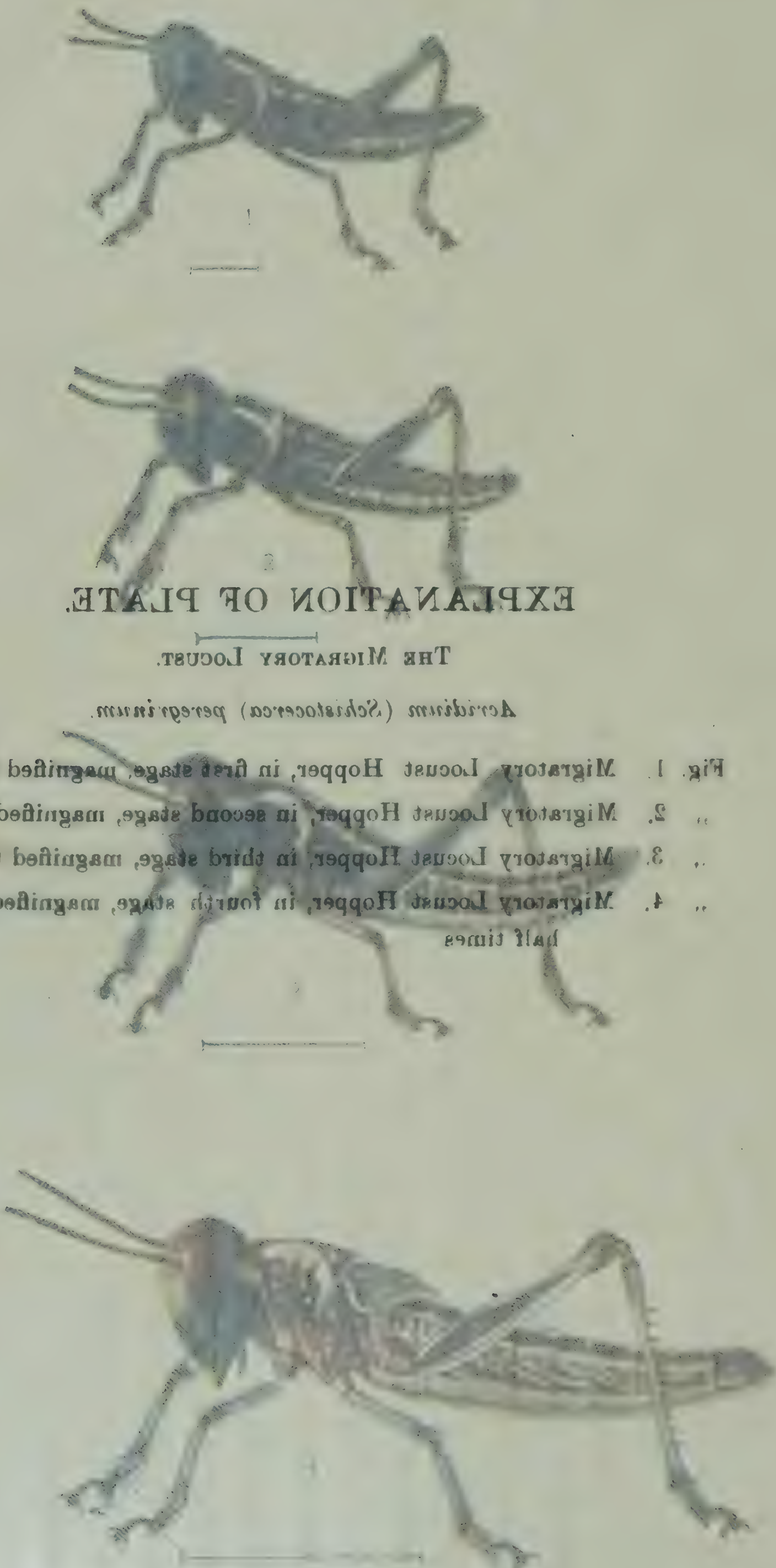
Fig. 1. **Migratory Locust Hopper, in first stage, magnified five times.**

" 2. **Migratory Locust Hopper, in second stage, magnified four times.**

" 3. **Migratory Locust Hopper, in third stage, magnified three times.**

" 4. **Migratory Locust Hopper, in fourth stage, magnified two and a half times.**

PLATE VII.



LOCUSTS IN BALUCHISTAN.

BY

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Political Agent, Chagai.

LOCUSTS appear in Baluchistan at intervals of every few years, always arrive after years of good rainfall, and as our records show, enter the province from the Persian side. The flights deposit their eggs in soft soil and for this purpose the Registan or "Country of Sand" is much in favour. From the plains, the flights move up into the Baluchistan hills, from whence they find their way down to Kachhi and thence into Upper, and, no doubt, Lower Sind. Up to a comparatively recent date the means at our disposal for ascertaining from whence these locusts came was insufficient. Following, however, the appearance of the first of last year's flights, steps were taken to trace them up, and the result of several months' patient investigation tended to show that the swarms had started from the Dasht-i-Lut or Great Kirman Desert, as it is also termed (*vide* map below). The precise breeding grounds in this Dasht were never actually traced, but as flights, coming from the same direction, made their appearance almost simultaneously in the Bam District, in Mashkel, in Kharan, in Sarhad, in Seistan, in Neh Bandan, and in the Valley of the Helmand, we may take it that the Lut breeding grounds embrace a very considerable area. In general characteristics, the *Acridium peregrinum*, which is our Baluchistan locust, closely resembles the *Acridium purpuriferum*, which is the locust whose depredations are a household word in South Africa. Both locusts appear after intervals which may extend to six or eight years: both appear after years of good rainfall: both deposit eggs under conditions relating to soil, climate, and moisture, which are identical: in both cases the hoppers, or, as they are termed in South Africa, the "voetgangers," pack into


AFGHANISTAN
PERSIA
DASHT-I-LUT OR GREAT KIRMAN DESERT
NEHBANDAN
SEISTAN
R. Helmand
BRIT. BALUCHISTAN
Quetta
Nushki
Chagai
Kharan
Koh-i-Malik Siah
Kirman
Bam
SARHAD
Hamun-Mashkel
Mashkel
KACHHI
Jacobabad
BALUCHISTAN
R. Indus
INDIA
SINDH
Karachi
ARABIAN SEA
OMAN
English Miles
56
58
60
62
64
66
68
34
32
30
28
26
24

dense columns which move in a direction it is impossible to change, and devour all vegetation which comes in their way: both are essentially desert insects needing hot-dry climates for their breeding operations; and neither one nor the other are seen, except it may be sporadically, in places possessing moist damp climates. The *Acridium peregrinum* is widely distributed, being met with not only in Northern India and Persia but also in Arabia, Cyprus, and even in Algeria and Morocco. In yet one other particular the *Acridium peregrinum* now proves to resemble its African *confrère*. The investigations of the South African Government Locust Bureau have shown that the periodic locust plagues which scourge the South African colonies all radiate from the Kalahari Desert, that desert area which occupies the centre of South Africa. These investigations have also established the fact that locust eggs retain their vitality unimpaired for several years and that, to hatch out, they require moisture, combined with a heat of 90 degrees. The observations made, last year, in the Chagai District, brought to light the fact that the places selected by the parent swarms for the deposit of eggs were invariably in a soft, damp soil, and no case came under notice where eggs were placed in ground which did not fulfil these conditions. From the data now collected there is strong reason for supposing that the parent swarms of locusts which enter Baluchistan, at intervals of every few years, come from the Kirman Desert, and that this desert plays the same part in locust economy as does the Kalahari Desert in South Africa, forming a central breeding ground from which the parent flights radiate for hundreds of miles, and that for some unknown reason, but which is also found in the case of the Kalahari region, certain of these flights find their way back to the Great Kirman Desert to lay their eggs again and to start the whole vicious circle revolving once more. Once a parent flight has started out in the world on its career of devastation, what happens seems fairly clear. A suitable locality having been selected, eggs are deposited. This is done in the form of an egg pod which varies in length from 1—2 inches and which, in general appearance, resembles nothing so much as a section of

lead pencil. Pods contain some 70 eggs laid vertically, each egg being attached to its fellow by a gelatinous substance. A seer weight of eggs represents about a lakh of young locusts which gives about forty lakhs of these pests to the maund. Provided the weather conditions are favourable, the young hoppers hatch out in from ten to twelve days. Eggs hatch in succession, the result being a procession of minute red insects which, a few minutes after emerging from the ground and exposure to the air, assume a black, almost coal black, colour. The young hoppers make at once for the nearest vegetation, on which they start feeding. They pass through various moults, attaining maturity in about six weeks' time. Selecting a day when a strong wind is blowing in a favourable direction (and the important part which wind plays in the movements of these hordes is not, perhaps, quite fully realized) the young locust swarm launches itself into the air and starts, in turn, on its career of devastation. Locusts are understood to attain an age of three months, and during this time they mate and deposit eggs. From the investigations made last year, it was not quite certain whether the whole swarm deposited its eggs together or whether eggs are laid in a succession of favourable places, as the swarm forges ahead. The evidence seemed rather to point to the latter being the case, for a swarm known to have pitched and deposited eggs was found, later on, to contain many females distended with eggs. Each flight seems to be endowed with a determination to prolong the line of flight which was followed by the parent swarm and none of the flights which bred in Chagai, or Valley of the Helmand, last year, was known to have returned to Persia. The nomad Baluch collect quantities of females in egg and use them as an article of food, their practice being to parch them over a slow fire and store them in bags, until used. Locusts treated in this way are said to keep for four or five weeks and to form quite a nutritious food. It has been observed that once a locust visitation has started, it does not spend itself until the lapse of a period of from two to three years. This is probably ascribable to two main causes. The time must naturally come, as the flight advances depositing eggs and propagating its species, when the temperature

PLATE VIII.

THE NORTH-WEST LOCUST.

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EXPLANATION OF PLATE.

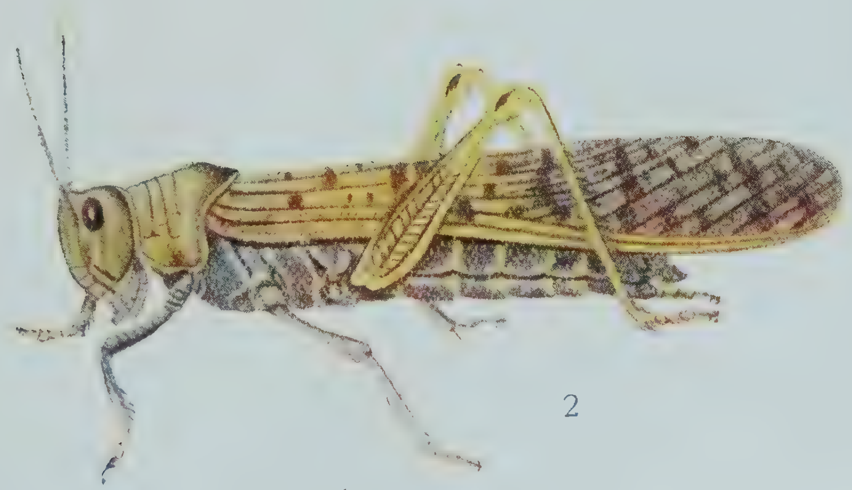
MIGRATORY LOCUST.

Acridium (Schistocerca) peregrinum.

Fig. 1. Migratory Locust in swarming colouration.

„ 2. The same in egg-laying colouration.


1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THE NORTH-WEST LOCUST.

of the waning summer is not sufficient to hatch out eggs, and these have, therefore, to lie dormant in the ground until a new summer brings with it such conditions as are required. The other cause relates to the moisture which plays so important a part in the hatching of locust eggs, and which is evidently a special provision of Nature, for moisture accompanied by heat postulates the necessary supply of vegetable food for the young locust. Eggs will not hatch out unless kept well damped, and so it must frequently happen that the supply of moisture in the ground is exhausted by evaporation before the lower strata of eggs in each egg pod can hatch and, in such circumstances, these eggs must remain latent either until more rain falls or until the following Spring. The flights which enter Baluchistan make for Sind, and the question now arises, whether the locust visitations of Northern India and Sind which come round with such unfailing regularity are endemic, or are due to pulsations of locust energy which, starting from the Great Kirman Desert, spend themselves, in the course of two or three years, but not before each pulsation has wrought a devastation which is to be computed in lakhs of rupees. Locusts in the flying stage cannot be dealt with, and all that can be done is to prevent a flight settling on trees, gardens, or depositing eggs in standing crops. Given sufficient men, this task is not so difficult as would appear at first sight. If we assume the correctness of the theory that each parent flight starts from a common central breeding ground, it follows that if we can destroy the chain of life of each locust flight, we prevent the damage and loss which must otherwise ensue until Nature herself intervenes with climatic or other conditions which bring about the termination of the plague. If locusts cannot be dealt with in the flying stage, the matter is different when they are breeding and after they have hatched out. Prior to breeding, locusts assume a vivid yellow colour, quite different to the pinkish tinge they take on the last moult and before starting on their flight through the air. The appearance of yellow locusts, therefore, indicates that the flight is about to deposit eggs, and, where possible, steps should be taken to keep all such flights under observation. At this period the females are so

heavy and distended with eggs that they are unable to make long flights. On alighting on ground suited to the purpose, mating begins, and this is followed by the deposit of eggs in the soil. The female would appear to have the faculty of elongating her body for she extends it into the soil to a distance of about double its normal length. Grounds where breeding is taking place should, where possible, be marked out, by means of pillars, and as many people as possible should be set to work at once collecting eggs. A maund of eggs represents 40 lakhs of young locusts and the damage which 20 lakhs (if we allow 50 per cent. loss) of young locusts can do is very heavy.

If the breeding ground is near a village or crops and rewards sufficiently tempting are held out, it is sometimes not difficult to induce the villagers and their families to turn out and collect eggs. The quantity which one man, when he has acquired a little experience, can collect in one day is remarkable. The exposure of eggs to the direct rays of the sun for two hours, during the maximum heat of the day, has been found to destroy their vitality, and ploughing is thus a measure which can often be resorted to with advantage. It must, however, be observed that such destructive measures as these, together with those of a more mechanical type referred to later on can, with one exception, only be used when the flight is a small one and the eggs can be easily reached. When these two conditions do not exist, as is unfortunately so often the case, the only course which remains is to wait until the young hoppers appear and then to direct one's whole energy to their destruction. A series of experiments on locust destruction have been conducted by the Locust Bureau of the South African Government, and the result of these has been to demonstrate that poisoning with the preparation of arsenic, known as arsenite of soda, is far superior to egg collection or any other means of destruction. Experiments on the same subject, conducted by the Russian Government in Transcaspia, have resulted in the immense saving in crops from locust damage which the last decade has seen. The experiments conducted in Transcaspia are of particular value to us, for they were conducted under conditions which approximate closely to those found in

Northern India and Sind, and they indicate that, no matter how unfavourable the conditions relating to locality of the breeding ground may be, arsenite of soda can be employed with efficacy. This poison, mixed with molasses or sugar, is used as a spray, and if sprinkled on a narrow belt of vegetation or grass in front of a moving column of locusts, destruction follows within a period of four days. This method has not, so far as is known, been tried in India, but steps are now being taken to test it in Baluchistan. Another method of dealing with locusts, in the hopping stage, is to spray them with water in which a small proportion of soap has been dissolved. This clogs their breathing orifices and, second to arsenite of soda, has been found, perhaps, the most effective way of dealing with these pests, before they have acquired wings and taken to the air. There are various other ways of destroying young locusts. Shallow ditches provided with screens of American cloth are perhaps as good as any. Into these trenches columns of young locusts are slowly driven, and, as soon as the trenches are full, earth is either thrown in above and beaten down, or wood or grass sprinkled with kerosene oil is placed on top and ignited. In soft sandy soil, it has been found that cloth screens are not absolutely essential, provided that men, with brushwood brooms, are stationed on either side of the column so as to prevent the young locusts moving outwards away from the trenches. Another means which has been employed, in some places, with advantage is an axle, bored at intervals with holes into which brushwood brooms are inserted, and mounted on wheels. As the axle revolves, the brooms sweep the hoppers into a sack provided with a wide mouth, which is trailed along the ground. From time to time the bag is emptied and its contents burned. Hoppers pack at night under the bushes on which they have been feeding, and another means of destroying them is, therefore, to spray these bushes with kerosene oil and set them alight. Special instruments, called torches, can be obtained for this purpose. In some places it may be found advantageous to resort to this method of destruction, but it has the disadvantage of being both clumsy and expensive. To all mechanical means of locust destruction, other than spraying, one great disadvantage attaches, a disadvantage which,

it will be found, also exists in the case of egg collection, and this is that it postulates the employment of a very large body of men, if any really appreciable results are to be obtained. Now zamindars are, as a rule, supine and difficult to move, and although it may happen that some particular energetic District Officer may occasionally succeed in inducing his cultivators to turn out and combat these pests, yet the fact remains that the task is an uncongenial one, and rather than face the toil and trouble which a locust campaign involves they are prepared to see their crops suffer. The Indian is both by inclination and nature a fatalist, and he is apt to prejudice, at the start, any attempt to combat a locust invasion by believing that he is engaged in a hopeless struggle against impossible odds and a struggle which his forebears had always declined to face. In addition to this there is the further objection that the *Acridium peregrinum* is a desert locust and prefers to deposit its eggs in soil which approximates to desert conditions, and it follows that in the localities it favours for propagating its species, it is rarely possible to collect the number of persons necessary to carry on an efficient campaign. On the other hand, as has been found in Transcaspia, spraying offers no difficulty which cannot be overcome with a little trouble. It is inexpensive, needs a very few men to work, and these can conduct the campaign in places and under conditions which would, otherwise, be impossible. The requirements are merely a small machine fitted with a proper nozzle—that known as the Bordeaux nozzle gives the best results—the poison itself which is made up in drums, ready for use when mixed with water, and a supply of water which can usually be arranged for at little expense.

Note.—We have retained the names of these locusts as given in Colonel Webb Ware's manuscript, but would point out that the name *Schistocerca tatarica*, Linn., is used for *Acridium peregrinum* in Mr. W. F. Kirby's "Fauna" volume on Acridiidæ, whilst the name *Acridium purpuriferum* is given as a synonym of the South African Species, *Cyrtacanthacris septemfasciata*, Serv., in Mr. Kirby's Catalogue of the Orthoptera.—(EDITOR.)

SECOND REPORT ON THE IMPROVEMENT OF INDIGO IN BIHAR.

BY

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I. Introduction.

The results obtained, up to the end of 1913, on the improvement of indigo in Bihar were published by the Bihar Planters' Association in January of last year and copies were then distributed to the members. It is not proposed to recapitulate here the contents of the first report but to deal with the progress which has been made during the year 1914.

There are five main directions in which the indigo industry can be developed by scientific methods. These are as follows :—

(*a*) The production of an ample supply of good, well-grown seed at the lowest possible cost and with the least trouble to the planter.

(*b*) The production of the maximum yield of indigo and of *seeth* from the plant now grown.

(*c*) The improvement of the plant by selection so that the yield of indigo and of *seeth* can be still further increased. The selection work, both on Java and on Sumatrana indigo, is in progress at Pusa and the results will be published next year.

(*d*) The preparation of finished indigo, in a standard form of high purity, suitable for the Home dyers.

(*e*) Indirect improvements, such as the production of more valuable cover crops for Java indigo and the discovery of methods of increasing the efficiency of *seeth* as a manure.

The present paper deals with the progress made in establishing the seed supply, in improving the yield of indigo and also in finding a more valuable cover crop for the Java plant. Nothing has been attempted in the direction of studying the manufacturing process with the view of discovering the best way of producing pure indigotin direct from the plant. This is not necessary for the local trade, but it will have to be taken up if natural indigo is to make any progress in the European market. One of the great advantages of the synthetic product is that it is easily manipulated in the vats, whereas natural indigo varies greatly in composition and dyeing power and therefore requires expert supervision. Under modern conditions of production, this is a great disadvantage.

II. The Manufacture of Indican.

From the standpoint of the planter, the indigo plant is grown mainly for the sake of the indican in the leaves. There is a byeproduct called *seeth*, which consists of the plant residues after extraction and which is a very valuable manure. In the manufacturing process, the green plant is steeped in water, the indigo is precipitated, collected into cakes, dried and sold as a dye. It is usual to apply the term manufacture to the process of converting the indican in the cut plant into indigo cakes in the factory. This, however, is not the whole matter as the indican itself has to be manufactured first of all by the growing plant. The present section deals with the manufacture of indican by the plant and with the conditions under which this process goes on. It will be clear that this is the centre of the whole subject and that *the future of the indigo industry in Bihar will depend, first and foremost, on the capacity of the planting community to apply the principles set*

orth below and make the plant produce the maximum amount of indican.

Indigo is a leguminous plant and, like all members of this order, is characterized by a high percentage of nitrogen in the seeds. This nitrogen occurs in the form of proteids and is placed there by the plant for the sole purpose of nourishing the seedling in the first stages of existence and supplying the protoplasm of its growing cells with nitrogenous food until it can lead an independent life.

When sown, the indigo seeds at first make no growth above ground beyond the two small seed leaves. All the development is subterranean in the form of roots, and, at a very early stage, and before the first real leaves are produced, swellings, known as nodules, begin to appear on the roots. Soon afterwards, indican can be detected in the first real leaves, but this substance has not yet been found in the seed. These root nodules are of the first importance in indigo (as in all leguminous crops) and, as will be seen later, everything in indigo cultivation and also in the separation of the indigo from the green plant in the factory, depends on the successful working of these root nodules[1] and of the roots.

The essential points about these nodules are two. In the first place, they contain bacteria (*Rhizobium*) which have the power of assimilating the free nitrogen gas of the atmosphere and working this up into materials from which the indigo plant makes the proteid it requires and also the indican in its leaves. In a sense, the first stage in the production of indican is the nodule of the indigo root and the source of this indican is the nitrogen of the air. In the second place, the food of the bacteria in the nodules is supplied by the plant and, for this purpose, substances of the nature of sugar are passed down from the leaves into the nodule to feed the bacteria. The arrangement is a true partnership between the bacteria and the indigo plant. The bacteria produce from the air the materials

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[1] The well-being of all leguminous crops in India depends on the aeration of the root nodules. It is true that the place of leguminous crops in agriculture has long been understood and the rôle of the nodule is now recognized. The agriculturist, however, does not always appreciate the needs of the nodule itself.

for making proteids and indican, in return the plant feeds the bacteria with sugars formed in the leaves. Leguminous plants, however, if grown in soil rich in nitrates, do not form nodules but absorb the nitrates direct in the same manner as other plants do. These essential facts of the work of the nodule, in the plant economy, must be clearly grasped at the outset as on this depends the understanding of this paper and the perception of the principles on which the improvement of indigo depends. It must also be remembered that those parts of the indigo root which absorb water and minerals also require air and will not work in the absence of oxygen gas.

The development and activity of the root nodules of indigo take place best when the plant is grown on somewhat poor land. On such land, the soil contains little nitrate, and, accordingly, the nodule factories are working at high pressure to supply the proteids required. Large amounts of the nitrogen and oxygen of the air are used up and the leaves of the indigo become rich in indican. Every planter knows that indigo grown on rather poor land (*zilla* indigo) gives the best yield of finished indigo and often the best colour. Poverty of soil in nitrates is one of the conditions for the production of numerous nodules on the roots and incidentally of high indican storage in the leaf.

When indigo is sown on rich land, containing a high proportion of organic matter such as *seeth*, the number of nodules formed on the root is small and the bacteria in them do not work at any great pressure. In such soil, nitrates are formed in abundance and the indigo plant then behaves like tobacco and takes up its nitrogen by way of the root hairs, in the form of nitrates dissolved in the soil water. Under such circumstances, the growth is rapid but little indican is accumulated and, if such plant is steeped, it gives a small proportion of indigo and moreover of poor quality indigo. This fact is also well known to planters and the inferiority of the crop from highly manured land, compared with *zilla* indigo, is understood by all.

The activity of the root nodules reaches its maximum about the time the plant is ready to flower. At this period, the leaves are

also rich in indican. At this time, however, the indican in the leaves begins to be called upon by the plant and to be utilized by the flowers and developing seeds. It is said that if the indigo crop bursts into flower, the yield of finished indigo will fall off and the colour will suffer.

The activity of the nodules depends on two main factors—a full continuous supply of air from the atmosphere and a supply of food from the leaves for the nodule bacteria. If either of these two things is interfered with, the nodule factory does not work. As regards the supply of air to the soil round the nodule, this is at first an easy matter in Bihar provided the surface soil is well and deeply cultivated and if crusts, formed by rain, are broken up whenever they occur. When the monsoon sets in, however, difficulties in the air supply to the nodules begin. If the monsoon is short and there are no large falls, the nodules get enough air and, if there is a succession of such years, the air supply in the soil is abundant and Java indigo reaches its maximum development. If, however, there is a heavy rainfall so that the soil is packed by rain and the air spaces destroyed and filled with water for long periods at a time, then the supply of the essential air to the nodules, and to the roots generally, is cut off and the activity of the whole root system, including the nodules, is stopped. At the same time, no further indican can be produced. When this happens, the whole economy of the plant is upset and it cannot manufacture any more food. A starvation period sets in and the reserves are called up. As at flowering time, there is an immediate run on the reserve indican and this is consumed. If the plant in this starving condition is cut, it will give a low yield of indigo, of poor colour just as flowering indigo does. As the starvation process proceeds, the plant begins to look unhealthy, the leaves fall and alter in colour and at last the stage, known as the wilt disease, appears. This is not a disease but the last phase in starvation, resulting from the destruction of the nodule factories and of the absorbing portion of the roots, the activities of which have come to an end. This has been brought about by the cutting off of the air supply by the heavy rains consolidating the soil and filling its pore spaces with water. This

cutting off of the air supply is not due altogether to the rain which falls direct, but is partly produced by the surplus water which runs off higher lands towards the low places. If this run off from other areas could be prevented, the damage could be lessened, and it is here that the Pusa method of drainage comes in to assist the indigo plant and the indigo industry. We should expect if the above is true, that indigo grown on land heavily manured with organic matter would show wilt sooner than indigo grown on poor land. The former has very little stored indican in its leaves and is not in a proper condition to withstand a famine. Experience shows that this is so, and that these heavily manured plants are very prone to wilt and even die off completely before the plants on poor land have used up all their stores and begun to show signs of the trouble.

Besides cutting off the air supply, the activity of the nodules can be interfered with if the bacteria in them are not fed by the plant. When young Java indigo, sown in August for seed, is cut down to the ground in October when about a foot high, practically all the plants die and very few shoot again. At this stage, little or no reserve food has been deposited in the roots and the nodules die of starvation. A few plants, however, just manage to survive and here again the new growth is wilted. At this stage, there is no reserve laid down and the whole plant rapidly dies of starvation.

The importance to the indigo crop of the nodules and of the absorbing roots is manifestly very great. Any interference with the partnership between the plant and the bacteria means a loss of indican and any serious trouble means the death of the plant, a condition which is reached through a wilting phase. The successful management of the indigo crop now becomes plain and simple and consists in running the nodule factory to its highest pitch. Not only is the yield of indigo thus increased, but the condition of the finished product is improved and good colour results.

III. The Improvement of the Yield of Indigo.

It will be clear from the preceding section of this report that the improvement of the yield of indigo depends on the supply of air to the roots of the plant and to the maintenance of the aeration

of the soil. It will be equally clear that the present practices in Bihar in growing Java indigo are about the worst that could be devised and that, in the past, the indigo plant has never had a proper chance. There has been no attempt at proper cultivation and nothing has been done to increase the air supply by means of surface drainage. The crops obtained have been the result of chance ; sometimes the colour has been good but most frequently it has been poor and only a low price has been realized.

The improved methods of cultivation that should be adopted with both Java and Sumatrana indigo are indicated in this section.

Cultivation of Java indigo. This plant is usually sown in October under a *rabi* cover crop. As soon as the cover crop is removed, the surface should be broken up as deeply as possible by means of lever harrows.[1] In this way, the soil is aerated and a full supply of air finds its way to the roots. The indigo at once responds and new healthy growth takes place. This harrowing must be done as soon as the cover crop is taken off and before the land bakes and gets foul with weeds. It must be thoroughly done and two to three inches of fine soil must be left on the surface. Weeds are also removed by the harrowing and the moisture is conserved. The main object, however, is to supply the nodules with air so that they can make new growth and store up indican. Any crust which forms by rain must be broken up by the harrows, otherwise the air supply is cut off.

When the plants are large enough towards the end of April or early in May, the indigo should be cross-cultivated, as deeply as possible, with the five tine spring tooth cultivator.[2] A few plants may be uprooted, but this does not matter as the indigo must start the monsoon with as much air in the soil as possible.

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[1] The best type of lever harrow to use is the two-section harrow made by the Massey Harris Company, Toronto, Canada, price 12.90 dollars, f. o. b., New York. The orders for these harrows should be pooled by the Planters' Association and the makers should be instructed to crate the wooden bars, otherwise these will disappear at Calcutta during the unloading process at the docks. One pair of Bihar cattle will draw these harrows easily.

[2] An agency for the supply of these cultivators has been established in Muzaffarpur. If the local supply is inadequate, orders should be sent to Messrs. Volkart Brothers, Lyallpur, Punjab.

The land on which indigo is grown should be drained by the Pusa system so that each field has to deal with its own rainfall only. This method was referred to in the last indigo report and it has been carried out, with great success, on the Dholi estate. Any planter can now see for himself this method in use on the large scale. This drainage system controls the rainfall and prevents waterlogging to a great extent. Consequently, under this method, the air supply in the soil lasts longer and the danger of wilt is diminished. Further, by keeping the nodules working by the increased air supply, the colour of the finished indigo will be improved.

The adoption of these methods in most cases will result in two good cuts of indigo. After this, the stumps should be dug up and the land put into *rabi* crops. If this is not done, the land gets foul with weeds. None of this indigo should, under any circumstances, be kept for seed.

Cultivation of Sumatrana indigo.—This plant is sown at the beginning of the hot weather, and, in order to bring the moisture near enough to the surface for germination, the land has to be compacted to a great extent. By this means the aeration of the soil is partly destroyed and the young roots are liable to suffer from want of air. As soon as the plants are large enough, they must be cultivated with lever-harrows and this must go on till about three inches of loose soil have been worked up. The root system of this plant is not so strong as that of Java indigo, so the spring tine cultivator should be used with care. After the first cut, the land should be worked up and aerated by means of the spring tine cultivator or the ordinary plough.

When sown on moist low-lying lands, the soil should be well cultivated beforehand so that there is a good supply of air. Any loss of moisture will make little or no difference as it is air—not water—which is important in such cases.

Pruning indigo at the first cut.—It will be clear, from the point of view of the plant, that the whole economy will be upset when it is cut down completely at the first cutting. The transpiration current will be stopped and the stumps will bleed. The nourishment of the bacteria in the root nodules will be interfered with and

a great deal of the reserve food of the plant will be taken away. A few leaves should be left to carry on the transpiration current and also the naked branches at the base of the plant. This is a great advantage in wet years like 1913, when at Pusa the total yield of leaf was increased by about 30 per cent. by this means. This method of taking the first cut involves no extra expense and only a little trouble in teaching the coolies. It is no advantage to take the old wood to the steeping vats, indeed, it is a positive disadvantage, as the cost of transport is increased and the concentration of the liquor is lowered. The *seeth* is also of less value. To the indigo plant, struggling to make new growth in semi-waterlogged conditions, the maintenance of the transpiration current by the few leaves left and the reserve food in the old wood make all the difference between life and death, and besides accelerate the new growth.

The methods of cultivation advocated in this section were partially put in force on the Dholi estate for the 1914 crop. The result was a record yield of 23·5 seers of indigo and of 170 maunds of green plant per bigha. This is only a beginning and still better results are easily possible.

IV. The Seed-Supply of Java Indigo.

An ample supply of well-grown seed of Java indigo is the first condition of progress in rehabilitating the Bihar industry. As pointed out in the first report, the area under this crop fell from 70,000 bighas in 1910 to 15,000 bighas in 1913 largely on account of the difficulty in growing the seed.

In connection with the seed-supply, it must be remembered, that Java indigo is a leguminous crop and, in common with other members of this group, the seed contains a high percentage of proteids. Leguminous plants assimilate atmospheric nitrogen in their root nodules and by this means manufacture substances which can be worked up into new proteids in the leaf. Until the nodules are formed on the young roots, they are dependent on the reserve proteid stored in the seed. On this account, it is essential that when leguminous seeds are sown they should be well ripened and

of good quality. Hence, too much attention cannot be paid to the seed-supply in indigo. With poorly matured seed, the seedlings have no proper chance of establishing themselves and an uneven crop, full of weeds, is bound to result. During the last few years, the quality of the seed sown has been very poor and this is one of the reasons why the crop has degenerated so markedly.

In the first report the following recommendation was made on the subject of growing seed :—

"The Pusa experiments on the growth of Java indigo for seed point to very definite conclusions. In wet years, like the present, a crop of really good seed is, as a rule, impossible after cutting the indigo for leaf. In future, leaf-growing and seed-growing should be regarded as separate things. For seed, Java indigo should be sown about the middle of August on high-lying well-drained lands. The seed should be sown in lines, about two feet apart, so as to promote branching and ensure abundant pollination. At first, cultivation and crust breaking should be carried out with the lever-harrow, but when the plants increase in size, inter-culture and weeding should be done by means of the Planet Junior hand hoe. Grown in this way, indigo escapes the so-called disease and large crops of good, well-grown seed can be obtained."

This method gave good results on the Dholi estate and a fine crop of seed was obtained in February 1914. The plants, however, were rather too thick, but during the present crop they have been thinned considerably and stand about nine inches apart. The result is shown in Plate IX, and it will be seen that an exceptionally fine crop has been obtained. The weight of seed will be determined and the figures published in the next report. As far as can be judged at the time of writing (December 16th), the yield of seed will not fall far short of ten maunds to the acre. Similar results have been obtained at Pusa this year and, as far as this method of seed-growing is concerned, the experiences obtained at Pusa and at Dholi in 1913 and 1914 are identical. There is no doubt that this method of growing seed is very satisfactory and that it should be adopted on all indigo estates.

PLATE IX.

JAVA INDIGO FOR SEED ON THE DHOLI ESTATE.

The production of seed now offers no difficulty and yields of 8 to 10 maunds per acre can be obtained. High-lying lands, in a clean condition, must be selected for the crop, and it will be a distinct advantage if the field is drained on the Pusa system. Sowing must be done during the first half of August and the ordinary indigo drill, in which alternate shares have been removed, can be used. As soon as the plants are well established, the surface crusts should be kept broken with the lever-harrows. This is essential if the best results are to be obtained as indigo requires air for the root nodules and these nitrogen factories will not work properly if there is a crust (*papri*). About the middle of October after the *hathia*, the plants should be thinned by hand and they should stand about nine inches apart. The crop should now be cultivated as deeply as possible both ways with the five tine spring tooth cultivator, so that the upper four inches of soil are worked up into a fine mulch. On no account should this cultivation be omitted. Weeds are killed and the roots are given a full supply of air. The root hairs cannot work without oxygen while both oxygen and nitrogen are essential raw material for the nodules. It has been stated above that indigo seeds are very rich in nitrogenous reserve materials (proteids). This material is made by the plant from atmospheric nitrogen and the first stage in the process takes place in the nodules of the root. Air must therefore reach the nodule in abundance, and, for this reason, the deep cultivation for seed in early October is essential. If this is not done and the indigo plants are left in the hard, unbroken soil, it is observed that they set very few seeds and also begin to look unhealthy. The nodule factory cannot work for want of raw material and, in consequence, the supply of materials for the seeds is not available. The seeds are therefore not formed. A full supply of air to the roots is necessary for the production of a good crop of indigo seed.

As pointed out in the first report, the proper spacing of the seed plants is an important matter. The flower of Java indigo is a bee flower and the visits of these insects are necessary to bring about pollination. If the plants are too close together, they generally flower at the tips of the branches only and, even if flowers are

formed in the dense shade, the bees do not visit them. Air and light are necessary for the production of side branches, for the formation of flowers and for ensuring the visits of bees.

V. Indirect Methods of Improving the Indigo Industry.

There are two indirect methods of improving the indigo industry, namely, the provision of a more valuable cover crop for Java indigo and the better utilization of *seeth*.

Cover crops.—As regards a better cover crop for Java indigo, a new variety of wheat, Pusa 4, has been introduced which can be grown with indigo on high lands. This wheat is a rapid grower, does not tiller much, has a very strong straw and is provided with few leaves. On this account, the young indigo plants get a full supply of light and air and the two crops do very well together. To give the indigo roots enough air, the mixed crop should be well cultivated in November with the lever-harrow, the tines of which should slope backwards so that none of the wheat is pulled out.

This wheat has been grown with indigo on the Dholi and Hathowri estates for some years and has done uniformly well. A general average of twenty maunds of grain to the acre can easily be obtained. The wheat stands up well and is easily cut by a reaper, while in threshing there is no trouble. The grain separates out easily in the machine and the sample is a very fine one. It is much liked by the people and round Bunhar and Hathowri the *raiyats* are taking it up. A large supply of this wheat is available for seed on the Dholi estate this year. This variety is likely to fetch a premium at the Calcutta mills, so an effort should be made by the Indigo Planters' Association to establish a grade of Pusa 4 in Bihar for the Calcutta market. Later, when the cultivation spreads, shipments to England can be made.

The efficiency of seeth.—As is well known, *seeth* is a very good manure for tobacco, but its value depends to a great extent on its power of aerating the soil and of giving the tobacco roots an ample supply of air. Experiments are in progress at Pusa with the object of getting a better return from *seeth*. Evidence has been obtained that if the tobacco lands are mixed with small pieces of tile (*thikra*),

the amount of organic matter for the crop can be reduced. The cost is not very great and a plot which was improved at Pusa in this way nine years ago still shows its superiority. If the present supply of *seeth* can be made to produce the same results on two or three times the area, the factories will be materially assisted and the indigo industry will receive an indirect benefit. The large scale experiments on this subject will be completed by the end of the present year and, if the final result is successful, the method will be brought to the notice of the planters.

On February 10th, 1915, a large number of the leading members of the Bihar Indigo Planters' Association visited Dholi in order to see the improvements, referred to in the above report, in indigo cultivation and in drainage, carried out on an estate scale.

The Pusa system of surface drainage was explained in detail and areas of the estate were shown which have been transformed by surface drainage in a single year. In one case, a large area, which previously gave little or no return, was seen in chillies, the rental of which is now ninety rupees per bigha. In another case, some of the land which had previously been rendered very infertile by scour, was seen under tobacco under a rental of one hundred and forty rupees a bigha.

There was a large area under Java indigo bearing a fine crop of seed and also mixed crops of Pusa 4 wheat and indigo. Lever-harrows and spring tine cultivators were shown at work. This visit was a great success and the demonstrations were followed and discussed with the closest interest. It is hoped that meetings such as this will take place every cold weather and that it will be found possible to combine visits to Dholi and to Pusa.

NOTES.

Spineless Cactus.—In recent numbers of the Journal[1] there have appeared some accounts of the use made of prickly pear as a food for animals and of the difficulties experienced in getting rid of the spines in order to render the material fit for feeding purposes. It may therefore be of interest to some of the readers to know that some time ago the present writer came across several clumps of an almost Spineless Cactus near Mandalay. From all appearance it had been growing there, alongside the common spiny *Opuntia*, for a very considerable time and the only information that could be obtained regarding it was that it had been brought from Amarapura a few miles away and planted in its present position about the years 1888 to 1890. It would be interesting if one could ascertain whether the plant is really indigenous and whether it was known before Burbank produced his Spineless Cactus, but further attempts to obtain information have not been successful.

The plant when examined was of a duller green than the prickly pear around and although the small swellings or "cushions" (tubercles) exist they are free from spines. But on *some* of the cushions, particularly on the younger joints, there are a very few minute spinules. These spinules, however, are so fine that they are often scarcely perceptible to the touch and are also delicate enough to be rubbed off by hand and consequently easily got rid of. The "joints" are somewhat large, more regularly oval in shape, thicker and, as far as one can ascertain without careful experiment, at least as succulent as those of the ordinary spiny cactus. The situation is a very dry one and this may account for the some-

[1] *Agri. Jour. India*, Vol. IX, Parts II & IV, April & October, 1914.

what shrunken appearance of both the species when last seen. No flowers or fruits have yet been seen by the writer.

Owing to the fodder conditions of Burma and the small chances of scarcity, Cactus is very unlikely to be of any use for feeding purposes in this province and consequently experiments are not being tried with the plant. If, however, the Agricultural Departments of other provinces wish to experiment, arrangements will be made to obtain and forward a few cuttings.

The writer understands that trials of Burbank's Spineless Cactus have already been made in India but can find no record of results. The Cactus in question might lend itself to selection. The absence of spines and hairy tufts, the absence of even spinules from the older joints and the ease with which these, where they do occur, may be rubbed off, or otherwise removed, indicate that selection would be effective in producing a variety entirely devoid of armour. (E. THOMPSTONE.)

* * *

AN IMPROVISED STACKING APPARATUS.—The apparatus described below was used on the Bangalore Grass Farm during the harvesting season of 1913-14. It consists of an upright pole of 6 inches average diameter, 28 feet long, which is supported by a hinged tripod fixed to a movable collar clamped to the upright at a height of about 15 feet. The tripod consists of three poles of $4\frac{1}{2}$ inches average diameter, and 21 feet long each.

To the upright pole at a height of about 20 to 22 feet is clamped a projecting arm of $2\frac{1}{2}$ inches square iron, bent at the end into a ring of about 3 inches diameter. This arm projects about 18 inches from the pole and is made in the form of an inverted right-angled triangle of one piece of iron with a base 18 inches, side two feet long and the hypotenuse in proportion. The side two feet long is clamped with two clamps to the upright pole with the apex of the triangle downwards so that the base projects, and is supported by the hypotenuse—from the ring at the projecting angle of the triangle is hung a chain of three circular links made of one inch round iron, each link of about three inches internal diameter.

To the lowest link of the chain a pole of about $4\frac{1}{2}$ inches average diameter and 40 feet long is fastened from its centre by means of a winged clamp with a bolt of not less than one inch diameter passing through holes in the wings and the link. This long pole then hangs horizontally like a beam scale. To one end of the horizontal pole a hook on the end of a piece of short chain is clamped and two ropes, each about 30 feet long, are fastened about 2 feet from the end. To the other end another rope about 30 feet long is fastened.

The hooked end of the pole is pulled down to the ground by a man on one rope attached to that end and the bale is hooked on by the central wire, or the bundle of loose hay is hooked on by a piece of rope tied round it. The other rope attached to the hooked end of the pole is held by a man on top of stack. A man then lowers the unhooked end of the pole by pulling on the rope attached to that end, thus raising the bale, and when the bale has reached the height required, he moves round away from the stack, thus bringing the bale or bundle of hay over the stack. The man with the rope on top of stack assists him by pulling on his rope and guiding the bale.

The bale is then unhooked and the pole is swung round away from the stack, and the hooked end again pulled down for a fresh load to be attached.

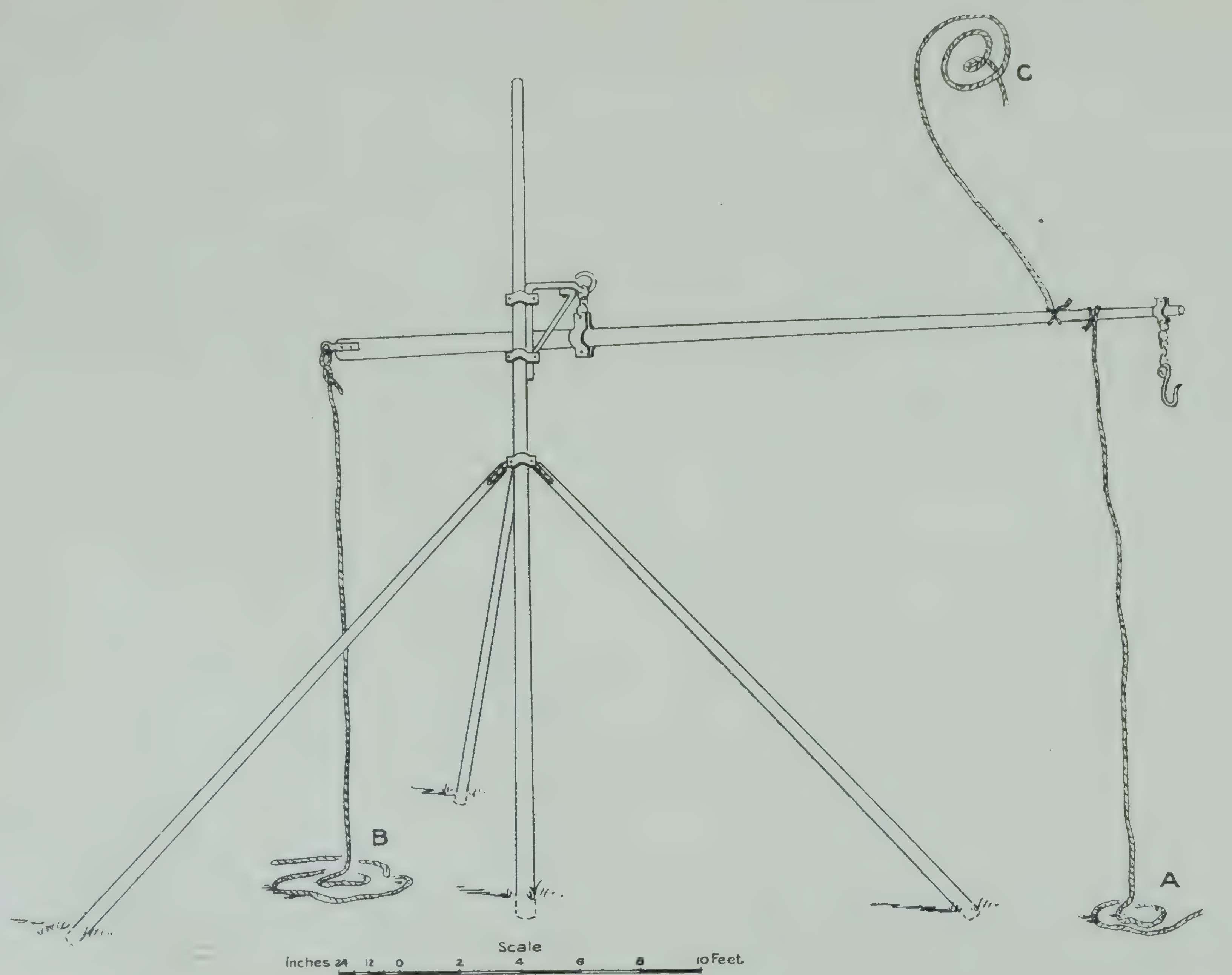
[As an alternative to the hook, a gripping appliance may be added in place of the hook at the lifting end. The arms of the gripper should be placed on each side of the bale, or, if the hay is loose, forced into it, and hoisted, when the gripper closes and holds the hay till it is lowered on the stack again.

This appliance will lift about 60 lbs. of loose hay at once. The hay should be cocked under the gripper and the two ends opened wide and forced into the cock as far as they will go.]

Instead of a 40 feet horizontal pole, a 28 feet tapered pole, tapering from 9 to 4 inches, may be used. It is hung at its centre of gravity and the hook end is the tip and the unhooked end the butt. The butt-end should be artificially weighted, if necessary, so that the centre of gravity will not be less than 8 feet from the butt. This will probably be found the most convenient arrangement,

SKETCH of STACKING APPARATUS IN USE ON BANGALORE GRASS FARM.

This shows the 28 butt ended tapering pole. The butt end to be sufficiently heavy to balance hooked end without load.



Sketch of gripping appliance for use with Bangalore pattern Stacker as an alternative to the hook.

Not to Scale

Points sharp.

Arms made of 2" × ½" flat iron

To be attached at "A" to hooked end of Stacker in place of hook.

A pulls down hook to ground and hooks on bale.
B pulls downwards raising bale to above level of top of stack and then moves round till bale is over stack and then lowers.
C on top of stack assists B to guide bale on top of stack and unhooks bale.
B keeping hooked end well up moves round till clear of stack.
A then pulls down again.
3 coolies at A.
2 " " B.
3 " " C.

as a 40 feet pole of sufficient strength and lightness is hard to get.

Cost of apparatus.—At Bangalore, using casuarina poles, and having the iron work made in the Sappers and Miners' workshop, the total cost was Rs. 40.

Cost of stacking with apparatus.—

Loose hay.—A stack 120′ × 30′ × 18′ containing 6 lakhs cost Rs. 23-7 per lakh pounds to make—labour required was three first class and five second class coolies. The stacking rate per lakh lbs. is approximately the same as that when the "Innes" elevator is employed, but while the cost of the "Innes" elevator is about £75 that of this apparatus is Rs. 40.

Baled hay.—A stack of 120′ × 30′ × 18′ was erected at the cost of Rs. 7-13 per lakh pounds—labour required was seven first class and five second class coolies.

The apparatus was found to be capable of hoisting a bale of 100 lbs. on to the top of stack at the rate of about 1 bale every 40 seconds and stacking was therefore done very quickly.

A sketch of apparatus, also of the gripping appliance, is given on p. 183.

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EXPERIMENTS ON THE PROFITABLE FEEDING OF MILCH COWS IN DENMARK.—These experiments take lucerne as a basal ration and are in the nature of a preliminary investigation as lucerne is of comparatively recent introduction into Denmark.

It would appear that lucerne was fed *ad libitum* to the groups of ten cows each and that the weight and milk yield of the individual cows did not stand in any approximately close relation to the amount of lucerne consumed.

This was followed by the introduction of an additional ration of 1·02 lbs. of oil-cake per gallon of milk which was given to group 1, while group 2 received an equivalent of oats, *i.e.*, 1·33 lbs. to every gallon. This oil-cake was fed to group 1 for 25 days and after that the experiment was reversed and oil-cake fed to group 2.

Despite the fact that the oats should have produced an equivalent amount of milk as the equivalent numbers were technically correct, the oil-cake in both groups produced the greater supply of milk.

From these facts the following conclusions were drawn, and in view of the fact that lucerne is now being extensively grown under irrigation for cattle feeding purposes and as a food for milch stock, they are of great interest.

1. Lucerne alone can only exceptionally and temporarily afford a profitable food for milch cows.
2. Lucerne combined with other foods is one of the best fodders for milch cows.
3. Under the given conditions, *i.e.*, when an economical ration was required for cows in good condition, the addition of oil-cake to lucerne was more favourable to the milk yield than the addition of a corresponding quantity of oats (on the basis of equivalents).

The following set of general rules may with advantage be given for the use of lucerne :—

1. As long as the lucerne is young it should be supplemented by roots or cereals.
2. For the succeeding two months it should be fed with oil-cake.
3. For the last month with oil-cake and roots.

[WYNNE SAYER.]

* * *

The Queensland Agricultural Journal for December 1914 has a note on a simple method of preserving eggs from which the following extract is made :—

"The main object of preservatives is to prevent the air from penetrating to the inside of the egg. But this alone will not entirely avert putrefaction because the elements of putridity already exist in the pores of the shell. Consequently, to obtain a perfect preservation, it is necessary not only to prevent the atmospheric air from entering the egg but to retain the life-power of the organisms in it.

"The eggs to be preserved by the following process must first be carefully examined to see if any are cracked or split. Such eggs must be rejected. Then the eggs are placed in a bath of lukewarm water (95 degrees Fahr.), in which they must remain for 15 minutes. When taken out they must be well rubbed with a soft rag to remove all dirt particles from the shell. When they are clean, they are placed in a sieve and plunged for 4 to 5 seconds in boiling water, and at the expiration of that time they are to be taken out and cooled off in cold water and laid on a cloth to dry in the air. Care must now be taken that they are not rubbed by the cloth. As soon as dry, they must be placed in boxes, and packed in chaff, chopped straw, oakum, or such like material and put away in a dry, cool place. The packing material must be perfectly dry. By the immersion in boiling water for 5 seconds, the fungi and bacteria in the egg are all destroyed. At the same time, owing to the high temperature, a coagulation of the inner tissue which unites the shell to the skin of the egg takes place, by which the pores of the shell are closed, thus preventing any further infection. The main difficulty of the operations lies in the timing of the 5 seconds while the eggs are immersed in the boiling water and the care required to see that the packing material is absolutely dry. If the eggs are kept in longer than 5 seconds, it results that, especially in thin-shelled eggs, a portion of the albumen under the skin coagulates, and that no destruction of the fungus germ takes place. Hence the whole result depends entirely upon the immersion of the eggs from 3 to 5 seconds, preferably 4 seconds, in the boiling water. This method, owing to its simplicity and cheapness, is adapted not only to the householder or farmer but also for those dealing largely with eggs in their business. Eggs preserved in this manner have been proved to be perfectly fresh and good, and could not be distinguished either in taste or smell from fresh-laid eggs."—[EDITOR.]

* * *

THE WILLINGDON MILCH CATTLE SHOW AT BELGAUM.—As the supply of pure milk is getting more and more difficult in Belgaum as in other places, the District Agricultural Association

of Belgaum has resolved to hold a Milch Cattle Show annually or at regular intervals to encourage the breeding and improvement of milch cattle. At the suggestion of the officers of the Agricultural Department it has been decided that the Show should be confined to that type of milch cattle in particular which possess the rudiments for developing good milking strain and which will both breed and get good milking stock in the future. The prizes to be offered will be substantial so that they may produce the desired effect on the exhibitors. A Show was held in April last and His Excellency Lord Willingdon, who takes a keen interest in live-stock improvement, was pleased to allow it to be called after him. The Show was chiefly remarkable in demonstrating the very poor yield of the local cows and the vastly superior capacity of Sindhi cows brought to Belgaum by the Military Dairy. The largest quantity of milk given at the two milkings together was 18 lbs. The cow that gave this quantity was a Sindhi obtained from the Military Dairy Farm at Belgaum and was bred and reared in the locality. The other prize winners were of local breed and were declared by the judges to give good promise if well fed and attended to. A number of men now propose to buy Sindhi cows and one or more selected bulls and so lay the foundation of a good local milch breed. This is to be done under expert advice.—[EDITOR.]

* * *

In the *Monthly Bulletin of Agricultural Intelligence and Plant Diseases*, Rome, for August 1914, there is an interesting article by Mr. C. W. Walker-Tisdale, on the dairy industry of Great Britain.

The author starts by comparing the value of milk as a food with its present price and shows that no other food of such nutritive value can be obtained so cheaply, and it therefore behoves the people to make every effort to keep milk at its present price.

After touching briefly on the way in which milk production is steadily ousting corn growing and stock feeding in England, some interesting figures are given showing the retail price of milk

in large towns and the way in which it maintains a steady price being about the only home-grown commodity which is absolutely free from foreign competition.

The author then deals with the question of milk production and its improvement by means of individual selection and his remarks have such an application to India that they may be quoted in full :—

"The question arises as to what is being done to cope with the increased demand for milk and the possibility of the demand being greater than the supply. As previously mentioned, more and more arable land is being converted into pasture, which is the main requirement for dairy farming; but apart from this must be considered the number of stock capable of being carried by the total amount of land available. Farming in Great Britain is still regarded as one of the less important industries, though there are many movements on foot at the present time to make it more productive and to increase the area of land available for agricultural purposes, by bringing under cultivation soil which at present is more or less unproductive. If, however, these points are left out of consideration, and it is assumed that the present available land is carrying practically all the stock it is capable of doing, which we think is by no means the case, there is still a means of increasing milk production. This is by means of increasing the yielding capacity of the dairy cows, or, in other words, devoting special attention to breeding and selecting animals for high yields of milk. A great deal of work is now being done in this direction both by individual dairy farmers and public bodies—work that ten years ago merited but little attention. If the average yield per cow, as is estimated for Great Britain, is only some 350 to 400 gallons, then it follows that much improvement is possible. Milk records are being carried out by various County Councils and Dairy Associations, the results of which show the quantity and quality of the milk yielded annually by each individual cow in the herd, and this information enables the farmer to retain only the cows which give satisfactory results.

"In Scotland a number of Dairy Societies have been started and have been in operation some five or six years, with the result

that Milk Record Schemes of great value have been obtained and much growth in this is being continued. It is found that in most herds the variation in the annual yield per cow is great, for whilst the poorest animal may give 350 gallons or less, the best may be yielding 1,000 or perhaps more. Now the cost of keeping and tending an animal yielding a large quantity of milk does not much exceed that of a poor cow; hence if only good cows of tested capacity are kept, as much as 50 per cent. more milk may be obtained from a similar number of cows.

"Most dairy farmers, even men who have been engaged in the work for many years, seldom know the milk yield of each cow in their herds, and milk records have shown as wide a difference between two herds on adjoining farms as 200 gallons per cow. Thus the farmer whose herd average 600 gallons per cow per annum, may look forward by exercising care in selecting his cattle to increasing the yield to 800 in the course of a few years.

"Numerous dairy farmers, however, do not breed their own stock, but instead buy cows which they retain for one, two or three years and then sell them off fat to the butcher. The calves of such animals are usually also sold to the butcher, and this system of dairy farming tends to reduce the quantity of milking stock in the country and many of the best dairy cows are thus lost. Such may be considered a very extravagant method of dairy farming, and to the farmer in this case milk records do not appeal, as he does not keep his cows a sufficient length of time and does not retain any of the progeny, even of the best ones."

The paper then goes on to deal with the factory system of dairying run on co-operative lines and its satisfactory effect in preventing a glut of milk at certain times of the year, and after a few remarks on the tuberculous regulations and the forthcoming Pure Milk Bill which is shortly to become law closes with a set of statistics showing the amount of milk brought into London daily by rail and the amounts of cheese exported and imported by the United Kingdom each year.

The fact that over 221,442 gallons of milk are brought from long distances into London each day goes to prove that the methods of

cooling, sterilization and general treatment of milk are now so perfect that it should be possible to get pure milk almost anywhere, and this fact, with the assistance of the railway, should in time solve the milk question for most of the Indian cities, despite the disadvantages caused by excessive heat, slower trains and greater uncleanliness under which any undertaking of this kind in India would be bound to labour.—[WYNNE SAYER.]

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A suggestive paper on "The Organization of Co-operative Dairy Farming" was contributed by Mr. V. H. Gonehalli, Assistant Registrar of Co-operative Societies, Bombay Presidency, to the Co-operative Conference held at Poona in August 1914. It is well known that the dairy industry in India is in a very unsatisfactory condition and is in need of improvement. The reasons for this unsatisfactory condition are manifold. The dairy business in India is followed by cultivators and by professional milk-men (known as *gowlis* in the Deccan) who generally live in large cities and towns. Most of the latter do not own or rent land for cultivation; nor do they grow fodder crops for providing green food for their cattle in the hot season. They have, therefore, to purchase for their animals, grass, oilcakes, bran and other feeding stuffs at high prices. The manure produced by the animals is not profitably utilized. The *gowlis* as a class are poor and are in the hands of money-lenders who charge heavy interest ranging from 2 to 4 per cent. per month. There being no proper organization, the cost of marketing milk is out of proportion to the price realized. The result is that the milk yield not being heavy as a general rule, the *gowli* invariably adulterates it with water to make the business pay. The cultivators, also, who keep milch cattle do not grow sufficient fodder crops. The cattle are overfed with green grass in the monsoon while in the hot season they do not get sufficient fodder and lose condition. This irregular feeding is extremely bad and the result is that the milk yield is seriously affected.

The process of milking the animals is also insanitary. The pot in which the milk is drawn is simply washed with cold water which does not destroy the bacterial germs. Milk is drawn from udders with moist hands and water is frequently applied to the fingers in the course of milking. This practice contaminates the milk.

Thus, while the supply of milk and milk products is far from sufficient, the quality of what there is is bad. It is therefore necessary to devise measures not only for increasing the supply but also for placing the industry on a sanitary and economic basis.

The extension of dairying in suitable tracts and its proper organization will go far towards solving the question of deficient supply of milk and its products in this country. The conditions most favourable for dairy farming are an adequate supply of water and grass. Villages situated on the banks of rivers which do not dry up in the hot weather, localities where a plentiful supply of tank or well water is available and tracts commanded by irrigation canals are considered suitable.

As the system of agriculture practised in many parts does not necessitate the farmer's labouring on the land throughout the year. the dairy business would pay him as a subsidiary industry and would enable him and his family to utilize their spare time. Taking the case of a particular part in the Thana District, the author says that if a cultivator keeps three Surati buffaloes (of which one is replaced every year) and if he grows fodder crops on his land and carries on the dairy business on economic lines, he can make a net profit of at least Rs. 100 a year, *vide* the estimates given on the next page. In these estimates it is presumed that out of the three buffaloes two will remain in milk throughout the year, the average yield of milk of each buffalo being taken as 10 lbs. per day.

Even if we allow a small sum as payment for insurance of cattle, it would leave a good margin of profit which would amount to a few rupees more if the cultivator looked after the cattle and cut the grass himself instead of employing hired labour. But as the ordinary

Expenses.	Rs.	A.	P.	Receipts.	Rs.	A.	P.
Concentrated food for two animals in milk for 8 months ..	180	0	0	Price of 7,200 lbs. of milk at 1 anna per lb. ..	450	0	0
Oil-cake for do. for 4 months ..	30	0	0	Price of one buffalo sold ..	60	0	0
Rent for grass land, cost of cutting, etc.	45	0	0	Price of two calves ..	10	0	0
				Manure	30	0	0
Price of green grass bought during 4 months ..	22	8	0				
Interest on the price of three buffaloes (Rs. 300) at 9 per cent.	27	0	0				
Price of a new buffalo to replace the one sold	100	0	0				
Wages of persons attending the animals	45	0	0				
	449	8	0				
PROFIT ..	100	8	0				
TOTAL ..	550	0	0	TOTAL ..	550	0	0

cultivator has not got the necessary capital for starting on this scale and, borrowing from money-lenders would deprive him of much of the prospective advantage, and as an organization is necessary so that the industry may be carried on under sanitary and economic conditions, the formation of co-operative dairy societies is advocated in localities, the suitability of which has been established by a thorough preliminary investigation.

Mr. Gonehalli suggests that the Society should collect capital by issuing shares each of Rs. 10 or more, raising loans and receiving deposits, the members of the Society being required to purchase a certain number of shares. It should advance money to its members at 9 per cent. interest. The sale of the milk and milk-products of the members should be undertaken by the Society for which it should charge a small commission. It should build a shed in the centre of the village where the members should be required to bring their cattle for milking under the supervision of a trained *mukadam* who would see that the milk-pots are properly cleaned. This precaution is especially necessary where whole milk is to be sold. The milk

should be collected by the *mukadam* and sent to the dairy room for sale. If there is no demand for milk in the neighbourhood, the Society should keep a separator and extract cream which can be sold as such or turned into butter or *ghee*. At present prices the Society will be able to sell these at a profit. The skimmed milk should be returned to the members as it is a nourishing food and can be converted into curds which are much liked by the people in this country. The proceeds of the sale, after deducting the commission, should be distributed to the members in proportion to the quantity of milk supplied by each. The expenses of the Society which should be kept at a minimum should be met from the amount collected as commission. The Society can help the members in purchasing fodders, oil-cakes, etc., at wholesale prices. District Local Boards can do a very useful piece of work by purchasing a good bull and handing it over to these societies for breeding purposes. Of course the societies should pay a part of the purchase price and be responsible for its maintenance. This will give an impetus to the improvement of the dairy breeds of the country.

In this connection it would appear that Government might also encourage dairy societies by giving them loans as they do now to co-operative seed societies and weavers' societies.

A co-operative dairy society of the type described above would be suitable also for villages, in the neighbourhood of towns, where cultivators are already keeping milch animals for supplying the needs of the urban population.

Mr. Gonehalli is of the opinion that the *gowlis* living in towns should be moved, stock and all, to suitable sites outside the town and organized into co-operative dairy societies so that arrangements can be made for the improvement of the industry on sanitary and economic lines. As an encouragement in such cases the municipalities might give aid in the form of sanitary accommodation and supervision at concession rates.

In conclusion, it is pointed out that the progress of co-operative dairy farming will not only be advantageous to the cultivators and the consuming public, but also lead to some improvement in the local system of agriculture.—[EDITOR.

THE SEED-TESTING STATION AT DUBLIN.—*The Journal of the Board of Agriculture*, London, in its issue for October 1914 has an article on "The Improvement in the standard of Quality of Agricultural Seed in Ireland," in which a brief description is given of the Seed-testing Station at Dublin established by the Department of Agriculture and Technical Instruction in that country. It is reported that the Station is fully equipped with all the necessary requisites for the testing of agricultural seeds and, in addition to the usual germination incubators heated by gas, has an experimental incubating chamber heated and automatically controlled, on the Grundy system, by electricity.

The following extracts show the nature of the work done at a seed-testing station and the two important respects in which the principles followed at the Irish Station differ from the Continental practice.

"At a seed-testing station, as is well known, the seeds are primarily subjected to tests for (*a*) purity, and (*b*) germination. The purity test is determined by weight, all the seeds not of the kind named in the designation of the sample, such as weed seeds, etc., being removed from a weighed portion of it, together with other impurities, such as sand, dirt, or débris of any kind. By weighing these impurities and making a simple calculation the percentage of purity can easily be ascertained. The percentage of germination is determined by placing a given number of the seeds from which the impurities have been removed (at the Irish Station this number is not less than 500, and in certain cases is 900) under optimum conditions for growth, and counting how many of them sprout or germinate in a given period of time.

"Seed-testing stations have been established on the Continent of Europe for many decades, and some of them—notably the Swiss one near Zurich—make a point of testing samples for clients of all nationalities.

"Although in the main the principles adopted at the best of these Continental Stations are the same as those in vogue at the Irish Station, yet there are two important respects in which those of the latter station do not coincide with Continental practice.

"The first of these is in connection with the tests made of the larger and commoner grass seeds. At most Continental Stations in testing such seeds for purity, not only are the real impurities, such as weed seeds, dirt, etc., removed and weighed as such, but so are also all the grass seeds which do not, or appear not to, contain a kernel or caryopsis. Since the germination test is carried out on the pure seed after the impurities have been removed, it follows that by the Continental method the germination test is made on *selected* seeds, and that therefore (particularly in relatively inferior samples) the percentage of germination will be higher than if the sample were tested by the Irish method. By the Irish method the germination test is carried out on the grass seed just as it is sold to the farmer after only the real impurities have been removed, and the result gives a fairer indication of the quality of the seed in the matter of germination. Of course, as regards purity, the Continental method gives lower percentages than the Irish does.[1]

"The second point of divergence is in the matter of controls. At the Irish Station there is tested side by side with every sample under examination a portion of a sample known as a 'control,' the germination of which is already known from previous repeated testings. If the control does not come up to its reputation when germinated alongside of the given sample, the test is discarded and a fresh one instituted. The 'control' sample, therefore, affords tangible and convincing proof of the perfection or otherwise of the conditions under which the germination test is being made. Owing to the fact that the best conditions for the successful germination of the commoner kinds of agricultural seeds are now so thoroughly well known from years of experimental work, it is found in practice that the failure of the control is of the utmost rarity; nevertheless its employment is a valuable safeguard against unforeseen and exceptional contingencies."—[EDITOR.]

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[1] For fuller presentation of the arguments in favour of the Irish method, reference should be made to the following paper:

Pethybridge, G. H. "The Methods employed in Testing Grass Seeds," *Journal of Economic Biology*, Vol. VII, Pt. 2, June, 1912.

REVIEWS.

Indian Forest Insects of Economic Importance. Coleoptera. — By E. P. Stebbing. London, Eyre and Spottiswoode; 1914. Pages xvi + 648, 63 Plates and 401 Text-figures. Price 15 Shillings.

In copying the above title considerations of space have prevented us from transcribing the author's full description of himself as given on the title-page, but we cannot help remarking that Mr. Stebbing's name does not appear in any list of Fellows of the Entomological Society of London since 1906. In his preface (pages v—x) the author refers to a former booklet of his entitled *Injurious Insects of Indian Forests*, but—possibly through a sudden access of modesty—omits all reference to his *Manual of Forest Zoology*, that precious classic to which we always turn for a hearty laugh in the dullest moments of depression.

The book itself deals entirely with Coleoptera (Beetles) and is presumably devoted (as its title indicates) to those species which are of economic importance to Foresters. But the first thing which strikes the reader is that a large number of beetles are included which have nothing to do with forest trees at all, and which, therefore, seem out of place in a book of this kind. As instances of this we may specify four different beetles given as attacking peach (pages 122—124), three as attacking coffee (pages 124 and 351), two more as found on grape-vines (pages 242—280), one as a pest of orange (page 346), several on mango, plantain, plum, etc.

The first four chapters are devoted to a general discussion of beetles with reference to their economic status in forestry, the fourth chapter including a short (20 pages) account of methods for the control of Insect Pests. On page 52 we read, "In nurseries,

bundles of some succulent crop plant poisoned with . . . . dilute kerosene may be placed on the seed-beds before the young plants come up. Caterpillars such as the *Agrotis* will resort to these and be killed ;" regarding this we would remark (1) that it is not usually necessary to take measures against hypothetical root-feeders before the young plants come up, and (2) that *Agrotis* larvæ, far from being poisoned by crop-plants sprinkled with dilute kerosene, would carefully avoid such. Again, on page 55, the author tells us that "to prevent pests such as caterpillars moving . . . . . . up or down the trunk, bands composed of a . . . . sticky material such as molasses should be painted on the tree" : we at once ask, what would be the cost of such an application and would further inquire whether Mr. Stebbing has ever tried this ? If so, we should imagine that every ant and wasp for miles around must have hailed him as a benefactor and, like Oliver Twist, asked for more ! An insecticide emulsion which should not "be allowed to get on to the skin of the operator" (page 55) seems to place itself rather outside the range of practical use. The perusal of this chapter leaves the reader with the impression that the methods recommended are more theoretical than practical.

Chapter V gives a short account of the characters of Coleoptera as a whole. The student should also refer to Canon Fowler's Introduction to the Coleoptera in the "Fauna Series."

Chapter VI commences an account of the Beetles in systematic order, the first family dealt with being the Passalidæ (pages 66—69). In the general account of this family we fail to find any reference to the extremely interesting social habits of these beetles beyond a bald reference to the fact that the larva stridulates. With regard to this point we read that "the first[1] pair of legs are short, striated, and stridulating sounds are produced with them." Mr. Stebbing tells us on pages 67 and 68 that he himself found Passalid larvæ,

[1] It is, however, only fair to Mr. Stebbing to state that he is not alone in this error. Lefroy also states in *Indian Insect Life* that it is the first pair of legs which are modified and the present reviewer has also repeated this mistake, copying Lefroy's statement (though with some doubt) in the absence of specimens which had been sent to another worker who was studying this group.

so that presumably this is his own description. Canon Fowler, however, tells us (*Fauna of India, Introd. to Coleopt.*, p. 206) quite correctly that "the first and second pairs [of legs] are comparatively long, but the posterior pair is rudimentary," whilst Arrow gives a figure in his volume on Cetoniines (p. 12). Passing over this discrepancy regarding a mere matter of fact, we proceed to the first species noticed and find that its name is given as *Leptaulax darjeelingi*, Knw., with the reference "Knw., Nov. Zool. V., p. 298 (1898)", whilst its habitat is given as "Darrang, Goalpara, Assam. Also reported from Mungphu, Tenasserim." The correct name of this common beetle is *Leptaulax dentatus*, and it was first described by Fabricius in 1792 ; it was re-described under the name of *darjeilingi* in the *Deutsche Entom. Zeitschrift* in 1891 by Kuwert, and again diagnosed by this author in 1898, under the amended name *darjeelingi*, in *Novitates Zoologicæ*, Vol. V., pages 297-298. Mr. Stebbing consistently uses the contraction "Knw." no less than seven times on pp. 67-69 ; it is therefore presumably not a printer's error. Is Mr. Stebbing unaware that this author's name is Kuwert, or is he merely careless of the correct usage ? This beetle is common throughout the Eastern Himalayas, from Darjeeling to Assam and in Lower Burma from Pegu to Mergui, whilst it also occurs in China, the Malay Peninsula and the adjacent islands. The description given of this beetle, as of all the species of this family, seems useless ; the Forester is not likely to do more than look at the figure given and to the Entomologist the description is inadequate for the recognition of the species.

The next species dealt with is given as "*Leptaulacides roepstorffi*, Knw.," from an unknown tree in the Andamans. The correct name of this insect is *Leptaulax roepstorfi*, Kuw., and it has also been found in the Eastern Himalayas, in Tenasserim and in Tavoy. We do not consider that the information given here will be of any use either to the Forester or the Entomologist.

The next species dealt with is *Pleurarius brachyphyllus*, Stol., which is recorded from Ootacamund. We have not found it there, although it is known from the Nilgiris, but we have found it not uncommonly in the Anamalais.

Then follows the genus *Basilianus*, of which we are told that "a species of this genus is common in the Eastern Himalayas." But we find no mention of *Episphenus* (*Basilianus*) *indicus*, Stol., and *E.* (*B.*) *neelgherriensis*, Perch., both of which are common in almost all the Hill Districts in Southern India.

The last species of this family mentioned is *Aceraius hirsutus*, Kuw., the reference given being " Knw., Nov. Zool. V., p. 343 (1898)," whereas this beetle was also described by Kuwert in 1891. The only locality given is Darrang (Assam), but this insect occurs throughout the Eastern Himalayas from Bhutan to Assam and in Upper and Lower Burma as far south as Tavoy; also in Cambodia, Hainan, the Philippines and Formosa.

We have gone through this family species by species because it is a small group, the first one treated in this book, and therefore presumably to be accepted as a fair sample of the whole. We consider that one page would have been ample to devote to this group and that a single good figure (such as No. 35), with a general note on the bionomics of these beetles, would have been sufficient to enable the Forester to recognize a specimen as belonging to this group, which is all that he wants to do. If, on the other hand, the book is intended as an entomological text-book, the omission of such common species as *Episphenus indicus* and *E. neelgherriensis* seems inexplicable.

We could go through the whole book and doubtless find similar material for criticism in almost every family dealt with, but considerations of space prevent us and we will only call attention to a few of the more obvious errors and omissions which we have noted.

Page 17.—" *Dichrocosis* " *leptalis* should be *Dichocrocis leptalis*; this mis-spelling is repeated in the Index and is therefore not a mere printer's error. Similarly, *Trachylepidia* " *fructicasiella* " should read *T. fructicassiella*; probably it had failed to strike Mr. Stebbing that the name was applied to this moth because its larva feeds on the fruit of *Cassia*.

Pages 13 *and* 89.—We are inclined to doubt whether *Oryctes* grubs do really destroy Casuarina seedlings or ever feed on living plant-food at all. The evidence adduced here, on the reports of two

Forest Officers, does not seem sufficient and we suspect that Cockchafer grubs were really referred to.

Page 22.—There seems to be little value in a statement such as the following :—" A species of *Meteones* is parasitic upon the caterpillar (*Tinea* sp.) defoliating the Kharshu oak, *Q. semicarpifolia.*" To the Forester these names mean nothing without fuller descriptions and recognizable figures, to the specialist the information given is too vague to be of any use at all. We assume that *Meteones* is a mistake (not misprint, as it is repeated in the Index) for *Meteorus*, and we doubt strongly whether the larva of any species of the genus *Tinea* ever " defoliates " any tree, since the larvæ of this group are rubbish-feeders as a rule although a few species mine blotches in leaves.

Plate VIII purports to show stems of *Poinciana regia* " girdled by *Xylotrupes gideon* " which is described on the opposite page, but without any reference to its early stages although the larva is figured in Canon Fowler's *Fauna* volume (page 214). We should like further evidence regarding this twig-girdling habit ; meanwhile we rather doubt it and suppose that these twigs were girdled by *Sthenias grisator* or some similar species.

On page 92 the Cetoniane beetle *Oreodorus gravis* is referred to as a " weevil," although on page 393 the Curculionidæ are correctly designated as weevils.

Page 95.—*Anthia sexguttata* (also figured in *Indian Insect Life*, by the way, though the fact is not noted nor the beetle figured here) is also common in Southern India.

Page 119.—Lefroy's note on *Silvanus surinamensis* is quoted, but there is no reference to the fact that this species is figured in *Indian Insect Life*, although the student would doubtless appreciate a note to this effect, seeing that it is not figured here.

Page 126.—Neither of the two Dermestidæ mentioned are forest insects.

Page 151.—Peradeniya is not spelled " Peradiniya. " On page 214 also we find a locality in Ceylon quoted as " Hovonapotani," a name which we do not recognize.

Page 196.—*Catoxantha bicolor*, Fb., is here recorded from Pyinkadu and doubtfully from Sal. This beetle has proved an occasional serious borer pest of Cacao in Java [see Zehntner, *Bull. No.* 1, *Proefstation voor Cacao te Salatiga* (1901), p. 8].

Page 237.—The date of Fabricius' *Supplement* (quoted under *Gonocephalum depressum*) is 1798 and not 1789.

Pages 238-239.—The references to *Tribolium ferrugineum*, *T. confusum* and *T. castaneum* are not likely to assist the student to discriminate between these three forms, and it seems very doubtful whether Mr. Stebbing has really done so himself. A reference to Blair's paper (*Ent. Mo. Mag.*, 1913, pp. 222-224) may be recommended.

Pages 247-248.—The eggs of the beetle described here as *Mylabris pustulata* are stated to be "laid in bunches on the leaves of shrubs and grass stems near the ground;" we have obtained eggs from numerous species of Meloid beetles and have always found them laid either in or on the soil, and never on leaves or stems. When Mr. Stebbing says that he has watched these beetles "feeding on the fruit of a species of *Artocarpus* in Dehra, peeling and stripping the pericarp down to the stone," it becomes difficult to follow his statement, seeing that fruits of *Artocarpus* have no stone.

Page 249.—The account of *Cissites testaceus* would have been more complete if it had included a reference to Bugnion's paper on the life-history (*Bull. Soc. Ent. d'Egypte*, 1909, pp. 182-200, tabs. 1-3).

Page 358.—*Cœlosterna* "*scabrata*" was named "*scabrator*" by Fabricius and there appears to be no good reason to alter its name. Similarly *Batocera* "*rubra*" was called "*rubus*" by Linnæus.

Page 366.—*Batocera albofasciata*. The only reference is to deGeer's original description written in 1775. Surely the student has a right to demand references to literature within the last century. Possibly Mr. Stebbing is unaware that this beetle has been described and beautifully figured in all stages by Dammerman (*Mededeelingen van de Afdeeling voor Plantenziekten*, No. 7, De Boorders in *Ficus elastica*, pp. 4, 10-17, t. 1, f. 1, t. 2, ff. 1a-f.). A reference to Sorauer's

Handbuch der Pflanzenkrankheiten (1906-1913), p. 501, reveals further information and references.

Page 375.—*Olenecamptus bilobus*, Fb. The references quoted are Fabricius' original description and Lefroy's *Indian Insect Life* (twice erroneously quoted as *Indian Insect Pests*). The distribution is given as "Dehra Dun; Gangetic Plains." The student may therefore be surprised to find that this beetle is stated by Dammerman (*l.c.* p. 8; t. 2, f. 4) to be widely distributed in *Ficus elastica* in Java and Sumatra also, and we think we are entitled to demand a fuller account of its distribution from a book which is expected to "have a wider sphere than that of India and Burma."

Page 379.—Lefroy's note on *Glenea spilota* is quoted, but the réference is twice misquoted as *Indian Insect Pests* instead of *Indian Insect Life*. In line 21 the word "died" should read "dried."

Page 393.—From the author's statements regarding the size of weevils it would appear that five to six millimetres in length is quoted as a minimum size. The student will find many weevils much smaller than this.

Page 414.—*Paramecops farinosa* is noted on *Calotropis* from the Punjab only. It is not evident why this species is included at all in a book on Forest Insects and as a matter of fact it occurs commonly, not only in the Punjab, but also in the North-West Frontier Province and in Madras and probably wherever *Calotropis* grows throughout India.

Page 415.—*Eugnamptus marginellus* is another non-forest insect, only recorded from mango. No reference is given to the original description, which will be found in *Deut. Ent. Zeit.* 1898, p. 299. The same remarks apply to *Cryptorhynchus mangiferæ* and *C. gravis*, both of which attack only mango fruits and both of which are unprovided with any references to literature.

Page 446.—*Odoiporus longicollis* is stated on very slender evidence to attack the coconut palm; we doubt whether it is ever a real pest of palms, though it is well known in most parts of India and Burma as a pest of Plantain. To describe the beetle as "light

brown" is misleading; the colour is very variable, from light brown to pitchy black, but most specimens are black. The student will find the synonymy of this species in *Ann. Soc. Ent. France* (6) V. 288 (1885); it is figured in *Indian Insect Pests* (p. 27) and *Indian Insect Life* (p. 382).

The book as a whole reminds us of the English alphabet, being at once redundant and defective. There is a vast amount of what can only be described as perfectly useless "padding," consisting of unnecessary repetitions (compare the two paragraphs on damage to seeds on pages 17 and 43), lengthy extracts from letters of Forest Officers, the inclusion of numerous insects which cannot be described as Forest Insects by any stretch of the imagination, and the devotion of pages to information regarding insects which cannot be identified either by the Forester or the Entomological expert because they are neither named nor even figured. The references given are very defective; thus, under *Oryctes rhinoceros* the only literature cited is (1) the original description by Linnæus in 1758, and (2) a note by Mr. Stebbing. Considering the extensive literature, both in and outside of India, on this destructive pest, this omission seems to indicate a vast gap in the author's information. Similarly the references quoted under *Rhynchophorus ferrugineus* (page 444) are very meagre and by no means up to date. In many cases, even the original references are either not given at all under the species cited (*e.g.*, pages 174-176, 181, etc.) or are defective (*e.g.*, page 287) or are incorrect (*e.g.*, p. 67). It is not apparent why several genera and species (see pages 405, 407, 412, 418, etc.) are described as "gen. nov." or "sp. nov." respectively, seeing that they were described as novelties previously to the appearance of this book and the original descriptions are even cited here.

When we say that most of the text-figures are the work of Mr. H. Knight, little more remains to be said regarding these; but some of the other figures are very poor and some indeed—we may instance numbers 125, 150, 157, 159 and 274—are atrociously bad. Figure 143, of *Belionota prasina*, is not good and would have been more recognizable if done on a larger scale. The Plates are generally good and many are excellent; Plates XI and XXXVI, however,

are much below standard and the former is a great contrast to Plate XV, which is excellent.

The Index would have been more complete and convenient if the insects dealt with had been indexed under their specific as well as their generic names.

This book is stated to have been published by order of H. M.'s Secretary of State for India in Council, and on page 249 the author indicates that at least another volume is in preparation. If this is so, we can only express a hope that a process of condensation may be rigorously insisted on and that the author may confine his attention to insects which are really pests of forest trees ; and we would further suggest that it would probably make for accuracy if his proofs were checked by competent experts before publication.

—[T. B. F.]

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Zeitschrift für Angewandte Entomologie, Vol. I, Part 1 ; pages 1-240, 2 Plates, a Map and 61 Text-figures. Berlin ; April, 1914. (Price for the whole volume 20 Marks.)

During the last few years there has been a good deal of interest taken in Germany in the subject of Applied Entomology mainly under the energetic leadership of Dr. K. Escherich, and this new Journal is brought out as the official organ of the recently founded German Society of Economic Entomologists. There are two articles on *Peritymbia* (*Phylloxera*) *vastatrix* in Prussia and in France respectively, followed by a note on racial differences between the forms of this insect found in Lorraine and in the South of France. Other articles describe the progress of Applied Entomology in Italy and in Germany and also in the German Colonies. This last, by Dr. G. Aulmann, is illustrated by twenty-five text-figures, most of which we remember to have seen before in this author's series of papers on the Fauna of the German Colonies ; both series seem likely to suffer from want of material in the future. Professor E. Zander gives a short but well-illustrated account of the Government Apiary at Erlangen. Dr. Teichmann provides a paper on the Biology of Tsetse Flies, illustrated by two Plates from rather indifferent

photographs, and other articles are on the Bionomics of Tachinid flies, the Mulberry Scale (*Diaspis pentagona*) and its parasites, the value of Insectivorous Birds, and on African Silkworms.—[T. B. F.]

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The Fodder Problem in the Bombay Presidency, published by the Government of Bombay, September, 1914. Price 2 annas.

This pamphlet deals with the different attempts which have been made to utilize the surplus stock of fodder from some parts of the Presidency to relieve the scarcity of fodder in others. This has been attempted in two ways; (1) by transport of natural grown grass at specially low rates on the railways; (2) by fodder storage (*a*) in stacks, (*b*) by ensilage.

The flaws in both these schemes are discussed in the pamphlet and various alternative methods are proposed, some of which seem likely to succeed.

New sources of fodder such as cotton seed hulls and prickly pear have been experimented with and the scientific selection of fodder grasses is recommended, as also the growth of fodder crops such as Bersim or Egyptian Clover under irrigation, while a combination of the various available fodders in certain proportions is also discussed.

But it would seem to hark back to one end which is that "the *raiyat* must be taught that it is worth his while to cultivate part of his holding with a crop for his cattle's consumption rather than to grow commercial crops over the whole area," and in this would seem to be the solution of the problem to a great extent.

To sum up the whole matter, it is merely a case of finding out how long it will take the *raiyat* to discover that it *pays* to keep cattle in good condition and fit for work, as they are an essential link in his farming, and, when he learns their value, not from a purely stock point of view, but from the value of the crops which can only be produced through the work they perform on the land, then he will be able to gauge the amount of land which he must set aside to feed his cattle, not regarding it as so much arable land wasted

from a food-producing point of view, but as a portion of his holding devoted to paying an insurance policy against famine and its results on his stock.

For this insurance policy to be paid by others will merely postpone the ultimate day when the *raiyat* will become an independent farmer and not as at present an individual whose methods of living on himself in good seasons force him to live on Government whenever a bad season comes along.—[W. S.]

* * *

Sugarcane, its Cultivation and *Gul* Manufacture—By J. B. Knight, M. Sc.—Bulletin No. 61 of the Department of Agriculture, Bombay. Price Annas 5 or 6*d*.

This bulletin deals with the varieties, cultivation, manuring, irrigation, crushing of the cane, boiling of the juice, its conversion into *gul* and the diseases of the crop. It refers mostly to the conditions existing in the Bombay Presidency and chiefly within the trap soil area. It is almost a complete guide for cane cultivation and *gul* manufacture, and on comparison with the same Department's previous Bulletin No. 25, it reveals the progress made by the Department towards the solution of various problems connected with this crop. *Gul* in Bombay Presidency usually sells at about 15 lbs. per rupee and it therefore pays the cultivator to manufacture *gul* rather than sugar. But the increase in the area under canal irrigation in the Deccan may in course of time make it necessary to convert some of the produce into sugar owing to the fact that the *gul* market is not likely to expand much. Until that time comes, however, there is a large amount of work to be done in popularizing the best methods of cultivation and *gul* manufacture worked out on Government farms. How paying the cultivation of this crop is in parts of Bombay is best seen in the following quotation:—

"The cultivation of sugarcane in the area under the canals is conducted on a very intensive system and crops are obtained which compare favourably with those of cane cultivation in any

part of the world. The net profits from the cultivation of this crop under canal irrigation are from Rs. 100 to 200 or more per acre: so it may be considered as a highly remunerative branch of agriculture for India where the average cultivator of cotton may get a net profit of Rs. 25 or 30 per acre. The margin of profit with food-grains is very low."

In connection with the manuring of this crop, the following remarks by the author will be read with interest :—

"When Mr. Mollison commenced the study of sugarcane, his first attention was directed towards the reduction of the amounts of manure and water then given to the crop. In his time he found that the cultivator frequently applied 750 lbs. of nitrogen per acre, and while admitting that only 100 lbs. of this element was required by the crop, he at first recommended that 500 lbs. be used. Later he conclusively proved that it was possible to raise maximum outturns with only 350 lbs. of nitrogen. Since his time we have been able to demonstrate that if the water-supply is regulated and carefully reduced to almost half the amount usually applied, a dressing of manure containing 250 lbs. of nitrogen will produce an equally good crop of cane.

"It is thought that with more extensive use of improved implements, which mix the manure more intimately with the soil, better methods of planting which reduce the quantity of water and the use of more available forms of nitrogen like mineral salts, the quantity of nitrogen required to produce a first class yield of cane, will more nearly approach that actually taken up by the crop, for in no part of the world is nitrogen so ruthlessly squandered as in the Deccan along the canal sugarcane tract."

It is interesting to record the author's conclusions in connection with the planting of canes arrived at after 10 years' work at the Manjri Farm. They are (1) that sets from "plant" cane are superior to those from "ratoon" cane, (2) that when all small and shrivelled sets are rejected a better crop will be produced, and (3) if only the terminal sets (*i.e.*, the three or four internodes just below the point where the leaves are lopped off at harvest) are used for

planting they will produce more vigorous growth of cane than sets of any other part of stalk. This is also more economical as this part of the cane is lower in sugar content than the rest of the cane. By this method not only is there less loss of sugar, but the remaining juice is improved by the elimination of this part of the cane and will produce higher quality of *gul*.

It is a sign of healthy progress that iron mills have to a great extent replaced the old wooden mills. It is stated that while the Nahan mill has less capacity and costs more than the Poona mill, a horizontal roller mill, known as "Pearl," for sale by Messrs. Clubwalla & Co., is reported to extract about 8 per cent. more juice and to give otherwise more economical results.

The practical instructions given for boiling the juice and the manufacture of *gul*, together with the factors which affect quality of this product will, it is hoped, be of great use to those for whom they are intended. We will conclude with a suggestion that the Bulletin might with advantage be translated into the vernaculars of the Presidency if this has not already been contemplated and copies distributed in the tracts where cane is a substantial crop.—[EDITOR.]

* * *

The value of Castration of Deccan Bullocks.—BY J. B. KNIGHT, M. SC., Professor of Agriculture, Poona.—Bulletin No. 62 of the Department of Agriculture, Bombay. Price As. 3 or 3*d*.

THIS bulletin appears to have been written principally with a view to remove the prejudice which prevails in the Deccan and Southern Maratha country against early castration of bulls not required for breeding purposes. In Gujarat castration of bullocks is practised when they are a year old while in the Deccan and Southern Maratha country this operation is postponed till they become five years old. Thus while Gujarat bullocks, although powerful and very active, are quite docile, those of the Deccan are rather difficult to manage and this militates to a large extent against the essential thoroughness required in working the areas used for intensive

cultivation such as cotton. The improvement in the breed of cattle becomes difficult in these parts as immature bulls are allowed to graze with the herd and to serve the cows. It is a popular belief in the Deccan that late castration develops the hump and promotes hardiness in the animal. The author describes an experiment made by him to test these points. His conclusions are as follows :—

1. That early or late castration does not materially affect the weight of the bullock.
2. That there is greater proportionate development in the hind quarters of early castrated animals.
3. That the strength is not impaired by early castration.
4. That the docility is markedly improved by early castration.
5. That activity is greater in early castrated animals.
6. To offset this the late castrated animals are perhaps better looking to some observers.
7. There is no proof of greater hardiness for late castrated animals.

As the Agricultural Department is trying to introduce improved implements and improved methods of husbandry, the necessity for more docile and active animals increases every year.

The sooner the cultivators realize the value of early castration, the better will it be for all concerned.—[EDITOR.]

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Substitutes for Rab.—BY J. B. KNIGHT, M. SC.—Bulletin No. 63 of the Department of Agriculture, Bombay. Price As. 3 or 3*d*.

IT may be mentioned at the outset for the information of the readers of this Journal that, within the tract of trap soils of Bombay Presidency where the rainfall is heavy, it is the custom to prepare the seed beds for rice by burning some substance like loppings of trees, dried grass or dung upon them before sowing the seed. This

substance is called *rab*. The seedlings are, when ready, transplanted to the fields which usually receive no manure. It may be noted that the yield from a treated plot is about 800 lbs. grain and 1,000 lbs. straw per acre, while that from an untreated plot is about 355 lbs. grain and 640 lbs. straw. It has been found that of all the substances used as *rab* cow-dung is the best, *ain* (*Terminalia tomentosa*) branches next to it and that leaf and grass are very inferior substances for *rab*. Investigations have also shown that the value of the *rab* is not dependent merely upon the manurial matter found in the ashes, but is to a large extent due to the heat. This practice may have originated in the ease with which branches of trees, etc., could be obtained in earlier times from the neighbouring forest at a trifling cost as the whole family of the cultivator did the work themselves and thus without any outlay reaped the advantages of increased crop production. But as in these days loppings of trees have to be brought from long distances and burning of large quantities of cow-dung cakes is not to be encouraged, experiments were made by the author to find cheaper and more efficient substitutes for *rab*, and the Bulletin under review records the results of these experiments. These may be summed up in the words of the author as under :—

That fish, nitre, sulphate of ammonia and oil-cakes are the most promising and that these may be safely advocated in the following quantities :—

Fish 120 lbs. per *guntha*[1] of seed bed.

Safflower cake (80 lbs.) 1 maund per *guntha* of seed bed.

Niger, Karanj, Ryan 120 lbs. ($1\frac{1}{2}$ maunds) per *guntha* of seed bed.

Undi 150 lbs. per *guntha* of seed bed.

Poudrette and sheep folding should be advocated wherever possible. The use of the former needs encouragement. Poudrette varies very much in composition, but about one cart-load per *guntha* should be applied. Nitre should be applied at the rate of 20 lbs. per *guntha* of seed bed and sulphate of ammonia at the rate of 15 lbs.

[1] A *guntha* is equal to one-fortieth of an acre.

Cow-dung rotted and well mixed with the soil at the rate of one small cart-load per *guntha* is to be recommended.

The following table briefly indicates the value of each of these substitutes :—

Rank.	Name of substitute.	Average outturn in lbs.		Quantity to be applied per *guntha* of seed bed.	Cost per acre of rice.	Cost per maund (80 lbs.).
		Grain.	Straw.		Rs. A. P.	Rs. A. P.
1	Fish ..	1,703·75	2,099·25	120 lbs. ..	7 9 11	0 5 8
2	Poudrette ..	1,207	1,331	200 to 300 lbs. ..	1 12 9	0 2 2
3	Safflower cake	1,457·3	1,653	80 lbs. ..	7 7 0	0 6 3
4	Sheep folding	1,300	1,750	140 sheep for three nights.	23 5 0	1 7 0
5	Niger cake ..	1,446	1,432	45 lbs. ..	22 15 0	1 4 5
6	Well rotted cow-dung.	1,146·6	1,188·2	600 lbs. ..	17 6 9	1 3 5
7	Sulphate of ammonia.	1,141	1,105	15 lbs. ..	20 0 0	1 6 5
8	Nitre ..	1,050·8	1,253·5	10 lbs. ..	12 0 0	0 14 7
9	Urine earth ..	1,020	1,009	1,000 lbs. ..	6 6 0	0 8 2
10	Household ashes	787·5	1,199·5	132 lbs. ..	18 0 0	0 14 0

[EDITOR.]

* * *

An Improved Method of making Jaggery.—BY ALFRED CHATTERTON, C.I.E., Director of Industries and Commerce, Mysore, Printed at the Vokkaligera Sangha Press, Bangalore.

THIS bulletin—No. 21 of the Mysore Industries and Commerce Committee—describes a system of furnaces and evaporatory pans designed by Mr. Chatterton to deal with the comparatively large amount of cane juice expressed by a mill, with rollers 12″ × 18″, driven by a 12-h. p. oil engine.

Such a mill, the author says, ‘ will easily deal with a ton of cane per hour, and the actual cost of working, including interest and depreciation, with an oil engine using liquid fuel or with a gas engine running on suction gas produced from charcoal, will not exceed As. 6 per hour’—about half the cost of crushing a ton of cane by bullock power.

Setting off this saving against the increased cost of carting cane from a larger area to a single centre, the advantage of the power

mill in juice extraction—estimated at a minimum of 10 per cent.—is left as clear profit.

An incidental advantage is the saving effected in time, enabling the cane on a proportionally larger area to be cut before it becomes over-ripe.

The necessity of designing an improved system of jaggery making arose from the inefficiency of the indigenous methods, when conducted on a large scale; in the author's words—'The ryot invariably employs a large shallow pan placed over a fire place constructed of mud, and for fuel uses the dried megasse from the cane crushing, and the trash from the cane field. With fibrous canes, this is usually sufficient, but when it is not so, he scours the neighbourhood for combustible material, and seldom, if ever, incurs any direct expenditure on firewood. The size of these open pans varies greatly in different parts of the country, ranging from a capacity for 250 lbs. of juice, to as much as 1,100 lbs. The usual time taken to convert the juice into jaggery is from five to seven hours. With a bullock mill yielding less than 300 lbs. of juice per hour, two pans will suffice; but, with a power driven mill treating one ton of cane per hour, and worked both day and night, at least 12 pans will be required involving the employment of one fireman to each pan, and two shifts of firemen in the course of 24 hours. Our experience with cane milling under such conditions has been extremely unsatisfactory; it proved impossible to properly control the firemen, the boiling was irregular, and the megasse from the mill insufficient, so that a very large expenditure on firewood had to be incurred.' In addition to reduced working costs per maund, the new system has been found to give an increased outturn of over 16 per cent. of jaggery from the same quantity of juice. The cost works out at about As. 4 per maund, on a basis of 12,000 maunds of jaggery per annum.

These figures should enable a rough idea to be formed of the possibilities of the application of similar methods to the manufacture of *gur* in Upper India; a sidelight is, however, thrown on the conditions obtaining in Mysore by a reference to the value of cane at Rs. 15 per ton—about double of its normal value in Bihar. It must

also be remembered that it is possible in Southern India to grow more than twice the weight of cane per acre obtainable in the North.

Nevertheless the progress made in Mysore augurs well for the solution of the similar problem in the United Provinces.—[A. C. D.]

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Report of an Agricultural Tour in Europe, America, and Japan during 1912-13.—By L. C. Coleman, M. A., Ph. D., Director of Agriculture, Mysore. General Series, Bulletin No. 4 of the Department of Agriculture, Mysore State. Printed at the Government Press, Bangalore.

The report is full of interesting observations and, keeping Indian problems always in view, Dr. Coleman has evidently gathered a large amount of information that will be useful, as regards, *e.g.*, the organization of demonstration work, the carrying out of crop experiments, soil moisture investigations, and the control of the silk-rearing industry.

Showing growth of Sugarcane on 1st July.

Fig. 1. Cane planted in October.

,, 2. do. January.

,, 3. do. March.

THE *GUR* INDUSTRY IN THE CENTRAL PROVINCES.

BY

J. McGLASHAN,

AND

D. CLOUSTON, M.A., B.Sc.,

Deputy Director of Agriculture, Southern Circle, Nagpur.

There were 17,392 acres under sugarcane in the Central Provinces last year. Thirty years ago the area was 42,551 acres. The area at present under this crop gives one no indication of the possibilities of cane cultivation in this part of India. The gradual decline is due to a combination of causes among which may be mentioned (1) the loss suffered by cane-growers during the last two famines, (2) the heavy cost of well irrigation, and (3) the reduced cost of transport by rail and the flooding of our markets with cheap *gur* in consequence. The opening up of the country by road and rail has, by facilitating the export of food grains and oil seeds and the import of cheap raw sugar from other parts of India, placed the local sugar industry at a disadvantage, in so far as it has now to compete with the cultivation of other crops which have risen largely in acreage value, and with cheap *gur* from Northern India. While the annual imports of refined sugar and *gur* have gone on increasing, the quantity of *gur* produced in the Provinces has gradually decreased. The statement below shows in maunds the average imports per annum of refined and unrefined

sugar for the quinquennia 1880-85 and 1890-95 and for the year 1913-14 :—

	Refined in mds.	Unrefined in mds.	Total in mds.
1880-85	1,06,103	3,85,222	4,91,325
1890-95	1,26,155	4,90,387	6,16,542
1913-14	7,52,730	8,72,662	16,25,392

The annual imports of *gur* or unrefined sugar have increased by 4,87,440 maunds since the first period 1880-85 ; the area under cane in the Provinces has in the same time declined from 42,551 acres to 17,392 acres. We may take it therefore that thirty years ago the quantity of *gur* and refined sugar consumed in the Provinces was approximately 16·6 lakhs of mds., and 1 lakh of mds. respectively, of which about 12·76 lakhs of mds. were *gur* produced locally, as compared with about 14 lakhs of mds. and 7·5 lakhs of mds. respectively, consumed last year including 5·2 lakhs of mds. of *gur* manufactured in the Provinces. There has thus been an increase of about 3·79 lakhs of mds. in the total quantity of *gur* and refined sugar consumed, due no doubt to the growing prosperity of the people.

We believe that the area under sugarcane has now reached its minimum and that with the irrigation works constructed and under construction large areas of land will shortly be brought under this crop which at present support herds of miserable cattle or produce crops of low acreage value. The crop can be grown in all classes of moderately fertile soil found in the Provinces ; but it gives higher yields on well-drained sandy loams such as *wardi* and *sehar* than on stiff clayey loams such as *morund* and *kanhar*. The varieties grown are mostly the hard ones, which being less toothsome than the thicker and softer varieties to jackal and wild pig are much less damaged by these animals.

The average yield of stripped cane and *gur* per acre for the Provinces is about 300 mds. and 30 mds. respectively ; the value of that quantity of *gur* at present prices is about Rs. 200. It is difficult to arrive at an accurate figure, as to the actual cost to the cultivator of raising an acre of cane, as only part of the work is ordinarily done by hired labour. When the crop is grown under tank irrigation in which case a water rate of

Rs. 7 is generally paid, and when all the work is done by hired labour, the cost per acre is about Rs. 120 including rent and water rate. If to this we add Rs. 9 for cutting and stripping, the cost of production of cane ready for milling is 6·9 annas per maund excluding cartage. Crushing and *gur*-making raise the cost to Rs. 162 per acre. The cultivator sells the produce, in *gur*, of one acre for Rs. 200 and therefore makes a profit of Rs. 38. To make the same acreage profit on the sale of canes it would be necessary to sell the produce, *viz.*, 300 mds. for Rs. 167. *i.e.*, at the rate of 8·9 annas per maund. Mr. Low in a note written by him three years ago on the same subject takes the value of cane to be about 9 annas per maund.

As a result of the high cost of cane grown locally, the area has continued to decline, because the grower has had to compete with more highly skilled cane-growers in other parts of India, who working under more favourable agricultural conditions can afford to sell cane at from 3½ to 4 annas per maund. But the cane-grower in the Central Provinces has other difficulties to contend with. In the very large areas of forest and waste land hundreds of thousands of wild pig are to be found which do much damage to this and other crops. The local method of *gur*-making, too, is most uneconomical. The furnace used is inefficient and consumes an excessive amount of fuel, about one cart-load of wood being required per ton of cane dealt with, in addition to the megass and trash. Much damage is done every year also by cane shoot borer and red rot.

These difficulties, though formidable, are not insurmountable. Wild pig can be debarred from cane by using the patent pig-proof woven wire fence which is now being supplied in considerable quantities by the Department for that purpose. The introduction by the Department of fhe Poona system of *gur*-making has solved the fuel problem. Red rot can, we believe, be controlled by giving greater attention to drainage and by selecting only the most disease-resistant varieties of cane for cultivation. Over 40 varieties are under trial on the Government Experimental Stations with this aim in view. The damage done by shoot borer can be almost entirely avoided by early planting. In a comparative test made this year, it was found that while less than 10 per cent. of the shoots of cane

planted in November and October were attacked by this pest, over 40 per cent. of that planted in February and March were affected.

Nine-tenths of the cane grown in the Provinces is planted between the middle of January and the end of March. The reasons for planting at this season are (1) that the cane-grower has by that time been able to complete the sowing of his *rabi* crops, the harvesting and threshing of his *kharif*, and the ploughing and manuring of his cane land. He is not a hard worker and always takes up his different farming operations in regular sequence. It is doubtful whether he has, in the course of ages, ever thought of altering his working time-table ; for, in this part of India where most of the *raiyats* are poor and illiterate and where the literate classes generally regard every branch of husbandry as forming a fit and proper occupation for coolies only, it necessarily follows that new ways of doing things are not tried. The wealthy and more intelligent malguzars are generally absentee landlords who take little or no personal interest in the management of their villages. The standard of cane cultivation for the Provinces is distinctly low, and the yield of *gur* poor. Much of the cane is still crushed by wooden mills which give a low extraction. Progress under these conditions must necessarily be slow and may remain so indefinitely, unless the industry can be made to attract more brains and capital. The opening of well managed factories for the manufacture of *gur* would go far to remove defects which are at present so obvious.

To run such a factory with a view to economy it would be well to have a working season of 120 days or approximately five months including holidays. In that case cane planting begun in the middle of January as is ordinarily done at present would have to be continued till the middle of June, so as to provide a five months' supply of cane for the factory ; but this is not practicable in the climate of the Central Provinces where the growth of cane planted after March is checked by the excessive dry heat of April and May. If it were possible to start planting in October and to continue it till the end of March this difficulty would evidently be avoided. A set of experiments is being carried out on the Tharsa and Sindewahi Experimental Stations with a view to ascertain how far earlier planting

Showing growth of Sugarcane when one year old.

Fig. 1. Cane planted in October.
,, 2. do. January.
,, 3. do. March.

can be practised with success. The outturns of plots planted in 1912-13 in black soil on the Tharsa Farm between December and March are shown below :—

Time of planting	Number of canes per acre	Weight of stripped cane per acre in tons	Weight of *gur* per acre in tons
Plot I December	64,2 0	25	3·1
,, II January	59,640	19	2·3
,, III February ...	42,040	10·3	1·2
,, IV March	37,000	8 8	0·8

The high yield obtained from the December plot encouraged us to try still earlier planting. In 1913 and 1914 cane was planted on the 1st of each month from October till March. The average outturns of cane and *gur* for the two years are given below :—

Time of planting	Number of canes per acre	Weight of stripped cane per acre in tons	Weight of *gur* per acre in tons
Planted in October	53,900	46·5	4·9
,, ,, November	47,200	42·4	4·3
,, ,, December	51,680	38·2	3·9
,, ,, January	45,400	36·6	3·5
,, ,, February	45,340	35·3	3·4
,, ,, March	32,960	28·1	2·8

The photos of the October, January and March plots show the height of the cane on the 1st of July, *i.e.*, in the beginning of the rains, and the height attained at the end of a year's growth. The October-planted cane was distinctly taller and gave a thicker crop. [Plates X and XI]

The outturns indicate that it is highly profitable to start planting three months before the usual time. Not only is a larger yield obtained by doing so, but the price of *gur* is at that time about 20 per cent. higher than it is later. The cane was in this experiment cut when thirteen months old. There is good reason to believe, however, that the increase in outturn due to early planting would have been still greater, had that planted in October or November been allowed to stand till about 14 months old. In an experiment carried out this year the October-planted cane gave 9,470 lbs. of *gur*

per acre when cut at the end of 13 months, and 9,900 lbs. when cut after 15 months. The November-planted cane gave 10,400 lbs. of *gur* when 13 months old and 11,344 lbs. when cut after 14 months. The chemical analyses of the cane of these plots planted at different times also go to prove that cane planted over a period of six months all tends to ripen about the same time, *i.e.*, about the middle of the cold weather. If a large area of cane had to be dealt with, it would undoubtedly pay a factory with its own estate to start planting in October. To get a sufficiently long working season it would be necessary in that case to crush some cane earlier and some later than the *optimum* date.

Cane planted in October and November tillers remarkably well, continues to make good progress throughout the cold weather and is sufficiently well established by March to shade all the ground and to stand the very high temperatures from March till the end of June ; while that planted three or four months later is handicapped from the very beginning by a scorching sun which heats up the surface soil to the detriment of the sprouting buds of the cane setts and of the tender shoots later. The temperature from October till January seldom falls below 46° in the shade : in March it sometimes rises above 105°. The table below shows the average shade temperatures for the last five years recorded at the headquarters of the two Divisions in which cane cultivation is likely to be largely extended in future :—

	Chhattisgarh			Nagpur		
	Highest °F.	Lowest °F.	Mean °F.	Highest °F.	Lowest °F.	Mean °F.
January	86·8	50·9	69·4	89·2	47·9	69·9
February	92·5	54·0	73·7	96·0	51·0	74·8
March	102·0	59 6	81·0	105·3	57·1	81·4
April	109·8	66·9	89 8	110·4	65·8	90 0
May	113·7	73·2	94·8	115·2	74·0	93·1
June	109·2	74·3	88·4	110 8	72·0	88·8
July	95·1	71·8	81·6	97·8	70·4	82·2
August	91·8	72·4	80·2	94·0	71·1	80·2
September ..	92·6	72·9	81·8	95·3	70·4	81·4
October	92·2	63·3	79·8	94·7	59·2	79·9
November ..	89·3	54·1	73·2	91·0	51·1	72·6
December ..	83·9	48·2	67·2	86·1	46·4	68·0

That excellent crops of cane can be raised in the Central Provinces may be gathered from the statement already given of outturns obtained from the plots planted in different months from October till March. The cost of cultivation involving heavy manuring as practised on Government Experimental Farms amounts to about Rs. 290 per acre and the cost per md. of producing cane ranges from 3·6 to 5·9 annas, according as the cane is planted early or late.

From an economic point of view it is highly desirable that the cultivation of cane should be extended in the rice tract where ample facilities for its irrigation are being provided by Government. The rice-grower has plenty of time between October and June to cultivate at least a small area of cane. Under existing conditions after harvesting his paddy and small *rabi* area he has a comparatively slack time till the rains break. He is busy during the rainy season with his rice. When he grows cane he has it ridged before the rains break so that it requires no further attention till the dry weather sets in again. There is a keen demand for labour in the rice fields during the rains ; in the absence of a demand in the dry season coolies have to leave their villages in search of employment on any Irrigation or Railway works which may be going on in the district. The extension of cane cultivation would thus meet a felt want in providing labour in the villages at this season. Looking at the question of extending the area from the cultivators' point of view, we find that the two principal factors limiting the area are, (1) the high cost of cultivation, and (2) the difficulty of getting a larger area crushed on the small bullock-driven mills in use. To remove the first difficulty *takavi* is already being given by Government to cane-growers. The setting up of small power plants by Co-operative Agricultural Unions would, we believe, go far to solve the second difficulty. But progress in this direction must necessarily be slow until companies of enterprising shareholders, backed up by ample capital, can be induced to start up-to-date sugar concerns with estates on which they grow their own cane.

Efforts in other parts of India appear at present to be largely directed towards the building up of a refined sugar industry. In the

Central Provinces with its comparatively small area under cane and with *gur* selling at extraordinary high prices, sugar-making is out of the question. The Hadi process was tried here and proved a complete failure as a business proposition. The manufacture of sugar on a small scale—that is from, say, twenty to thirty tons of cane per day, has no possible chance of competing with large factories, in which the charge for staff and machinery per unit of sugar made, is much lower. On the other hand, there is a large consumption of *gur* in the Provinces, and after all *gur*-making is the main sugar industry of India. The sugar consumption is only a fraction of the *gur* consumption. That there is a demand for a clean and attractive *gur* is shown by the prices paid for this article in the bazaars of the Provinces. *Gurs* from Chhindwara and Betul fetch as high as Rs. 13-5-0 per maund in the bazaars of Amraoti district. In Morsi the rate is Rs. 10-6 per maund. These are exceptionally good *gurs*, light in colour and with large crystals. Judging from the appearance of the samples from these and other bazaars in Berar, it would appear that these high quality *gurs* are made apparently by concentrating the juice to a less extent than is usually done in *gur*-making. The syrupy juice is then allowed to deposit crystals from which the molasses is drained off—sufficient only being left to stick the crystals together on drying slightly. These high grade *gurs* or rather raw sugars are in demand in Berar, where the people, being well-to-do, can afford to pay for a good article. The cheapest *gur* of the samples obtained from the bazaars of this division was being sold at the rate of Rs. 5-14 per maund. It was reddish in colour and of very good grain. In Khamgaon cheap up-country *gurs* were obtainable as well as clean high quality *gurs*. Baramati *gur* in this bazaar is sold at the rate of Rs. 7-4 per maund. The colour and grain of some of these *gurs* indicate that they have been formed by mixing Java sugar with damaged *gur*.

In the Chhattisgarh Division where the people are poorer and less accustomed to luxuries, we find less of the very high quality *gurs* for sale. The demand there is chiefly for the cheap and dirty *gurs* from Bihar and the United Provinces, which are sold at from

annas twelve to rupee one per maund above their cost in the bazaars of Gorakhpur district and Saran; but there is a small demand there, too, for high quality *gur* from Madras at twice that price.

Even allowing for differences in freight charges when necessary, the difference in price between high and low quality *gurs* in the Central Provinces and Berar is not due to the additional cost of making the better article, but to the fact that the supply of good *gur* is not equal to the demand. Sugar consumption will doubtless continue to increase as the country becomes more prosperous; but there seems no reason to suppose that *gur* consumption will decrease provided that a high quality *gur* is provided at a moderate price by improved methods. The improvements will have to be of a simple nature. Elaborate plant is to be avoided, otherwise charges for machinery and skilled attendants raise the cost too high on a small output.

AN IMPROVED FIBRE PLANT.

BY

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AND

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In a previous paper,[1] written in 1910, the varieties of the Indian fibre plant, *Hibiscus cannabinus*, L., Deccan or Ambari hemp, were dealt with from a botanical point of view. Of the eight types, belonging to five different varieties, described in this paper, one has consistently stood out from the rest as being the best for fibre purposes under the conditions obtaining at Pusa. This is Type 3, a kind which has always been characterized by great robustness and vigour and by its capacity to grow and set seed under comparatively unfavourable conditions. This type was described in the paper on this species as follows :—

"Plants fairly early, very robust, setting much seed. *Stem* tall, stout, prickly, red except the upper 6 or 7 inches which remain green. *Stipules* green. *Leaves* palmately divided into 3-7 (usually 5) lobes, a few are simple and subcordate, the upper leaves lanceolate. green ; margins red ; petiole red. *Peduncle* green. *Epicalyx* green with a few red spots. *Corolla* yellow with a crimson eye. *Seedlings* somewhat small, stem red ; petiole red ; cotyledonary leaves green."

[1] *Memoirs of the Department of Agriculture in India (Botanical Series)*, vol. IV, No. 2, 1911.

The tall, reddish, straight stems and the crimson eye of the flowers serve to distinguish Type 3 easily from the ordinary green variety grown in the plains which has a tendency to form side branches. Type 3 is taller than the ordinary crop, is resistant to wilt and is able to ripen seed under conditions when many of the other forms, isolated at Pusa, fail to do so. The roots do not seem to be so sensitive to water-logging and to want of aeration of the soil as those of all the other seven types. On this account, it has been adopted as the source of the fibre required in the Botanical Area, and has been grown very successfully for this purpose during the last five years.

One difficulty, with regard to the seed-supply of this form, had to be overcome before its cultivation could be advocated. There is a good deal of natural-crossing between the various types of *Hibiscus cannabinus* and when these are grown near to one another, pure seed can only be obtained from protected flowers. To produce such seed in bulk, in the case of a tall, unbranched plant such as this, is clearly impracticable except by the expenditure of large sums of money. Some easy method of keeping the kind pure had therefore to be devised. Pure cultures were obtained from the seed of unprotected flowers by the simple process of rogueing the plots of Type 3 very carefully in the seedling stage and again later on before flowering began. Almost all the heterozygotes can be distinguished as seedlings as they stand out clearly from the bulk of the culture. The stray plants are all removed by hand at the stage when the first pair of real leaves begin to form. A further inspection of the plot, just before flowering begins, serves to confirm the rogueing in the seedling stage and also to remove the very occasional heterozygotes which then escaped detection. In this manner, the new variety has been maintained in pure culture without difficulty in an area in which the opportunities for natural-crossing with the other seven types were much greater than in the fields of the *raiyats*. Thus by studying the seedling and vegetative characters of an improved variety, in the case of a crop in which natural-crossing is common, it is possible to apply the methods of pure line culture and to raise seed, true

to type, without the expense of growing it under gauze cages or by protecting the flowers with muslin or parchment bags.

The solution of the problem of keeping the improved type pure, under ordinary conditions of cultivation, having been solved, it became necessary to work out the best method of retting and to obtain expert opinion on the produce as compared with the fibre produced locally. The plants were cut in the ordinary way, allowed to wither for two days on the ground, made up into bundles and placed upright in the river. In this way, air enters the tissues and the thick end of the plant rets at about the same rate as the remainder of the stem. The bundles were then placed horizontal in the water and kept submerged by wooden beams laid across. They were allowed to remain until the fibre came away easily from the wood and could be washed quite clean from bark and gum. It was hung out in a line to dry for a day in the sun and then made up into hanks in the ordinary way. Thus the country method of retting was followed but care was taken to prepare the fibre thoroughly and to conduct the whole operation in clean, river water to the best advantage. Any cultivator, near a river, could carry out easily everything that was done in the preparation of the fibre sent for report.

A large sample of the fibre of Type 3 along with one of the locally prepared product, purchased in the Pusa bazaar, was submitted to Messrs. Wigglesworth & Co., 82, Fenchurch Street, London, E. C., for examination and report particularly with regard to the following points :—

"(1) Its value per ton in London compared with present supplies of this Indian fibre.

(2) Its value per ton compared with the locally produced sample submitted.

(3) Any advice or remarks with regard to the retting of the sample of Type 3 and whether it fully meets trade requirements as regards colour and condition.

(4) The best method of sending this fibre in bulk. It is presumed it should be sent in pressed bales but information is requested as to the best size of bale for this fibre and how it should be

folded before pressing." (Extract from letter dated Nov. 19th, 1914).

Mr. Arthur Wigglesworth (of the firm of Messrs. Wigglesworth & Co.), who has visited India in connection with fibres, was good enough to send a most interesting and detailed report, dated December 21st, 1914, which is given in full below :—

"I beg to acknowledge receipt of your communication dated Pusa, 19th Nov., 1914, and have also received the two samples of fibre of *Hibiscus cannabinus*, L. Having carefully examined these, I have the honour to make the following report :—

Sample of the improved variety (*Type* 3).—This is of excellent growth, being 10 to 12 ft. long, exceptionally light coloured, correctly retted, and thoroughly well-cleaned. Judging by the individual stalks I should conclude that the yield of fibre per acre must have been of quite exceptional weight. The fibre is pure from end to end and is free from root. It is also of good tensile strength and I have no hesitation in pronouncing it the best specimen of fibre from the *Hibiscus cannabinus* plant which has ever been submitted to me. This class of fibre could be sold in almost unlimited quantities.

Below I give categorical answers to your questions :—

(1) The value per ton in London of this fibre to-day I estimate at £18. This compares with the following values of Indian jute :—

So-called Bimlipatam Jute	£12-10-0
Bengal First Marks	£17-0-0
Dacca Jute No. 2	£20-0-0

It should be mentioned that Jute has fallen 50 per cent. since the war, Bimlipatam having been saleable at £26 per ton before August and First Marks at £32 on spot.

(2) The value per ton of the locally produced sample is about £ 8, but it is indifferently cleaned on the average and parts of it so inefficiently prepared that they would be scarcely workable on spinning machinery. It is considerably below the average of so-called Kottapatam Jute which generally sells at £2 to £3 per ton below Bimlipatam Jute.

(3) I do not consider it possible to improve on the retting or preparation of Type No. 3. As it is, this fibre would fully meet the trade requirements, both as regards colour and condition. The fibre, owing to its nature, is more brittle than Bengal Jute and but for this it would fetch as high a price as Dacca or superior Naraingunge varieties.

(4) The best method of sending this fibre in bulk would be to pack it in the old "Watson" press, constructed by the Watson Patent Press Co. in Liverpool, whose address I can send later.[1]

This turns out 30 bales per hour of 400 lbs. weight each pressed to 50 cubical ft. to the ton to ensure the freight being arranged for at the rate of 5 bales per ton. In Calcutta, they are using largely the "Cyclone," but this would knock this fibre to pieces as it is less pliable than Bengal Jute. It turns out 40 bales an hour. The fibre is so long that it would be necessary to fold it twice. In Calcutta it is usual to "head" the jute, that is, to give the jute in the centre one turn at the fold. In this longer jute, it would have to get a second turn so as to fit it into the press.

The samples you sent are of such exceptional length that I should almost judge that they had been grown on highly manured land of great fertility. For commercial purposes, I consider the jute is rather long and that it would probably be better if it were shorter, though of course the yield to the grower would be proportionately smaller.

I am pleased to hear that you propose to take up the spread of this variety of fibre in various tracts of India and to endeavour to get it taken up by the cultivators. I would strongly encourage you to carry out this programme which I feel sure would meet with success.

Bimlipatam Jute, which is prepared from the same plant, has recently increased in vogue, and though the brittleness and harshness of the fibre prevent it being spun into the finest yarns, it is nevertheless an excellent substitute for Bengal Jute (*Corchorus*

[1] The Watson Patent Press is manufactured by Messrs. Fawcett Preston & Co., Ld., Liverpool.

capsularis and C. olitorius). It is certain that the extension of its use will proceed still further so that the increased quantities you suggest producing would meet a natural demand.

I have read with the greatest interest the excellent pamphlet you were kind enough to send (No. 2, vol. 4 of the Botanical Series on some new varieties of *Hibiscus cannabinus*, L. and *Hibiscus Sabdariffa*, L). On page 11 you refer to the tensile strength of fibre obtained at certain periods in the maturity of the plant. Having had some experience in the production of Italian Hemp (*Cannabis sativa*) I would like to mention that that crop is cut when the leaves on two-thirds of the plant have turned yellow and started to drop, after the plant has flowered and the seed is just commencing to set. It has been found that the best quality and the highest tensile strength are obtained from plants cut at this period which is never allowed to vary whatever the weather conditions may be, the practice being that 10 per cent. of the female plants are left on the field to produce seed. They are cut about six weeks later and the fibre produced from them is inferior in strength, very coarse in texture, and lacking in essential oil.

I should like to know if the Type 3, alluded to on page 17 and so beautifully illustrated on Plate 3 as var. *ruber*, is the plant which has produced the fibre which you have sent.

I have consulted Mr. J. C. Duffus, who was a long time in Calcutta and is thoroughly conversant with the Bengal Jute trade, and I showed him your type sample No. 3. He entirely agrees with my valuation and report and points out that if you should wish to send home a few experimental bales, his house, Messrs. J. C. Duffus & Co., Clive Row, Calcutta, would be pleased to pack the jute for you and send it home to us for sale on this market. It will be well to get, at least 50 or 100 bales of it prepared next season and sent over so that we might have the fibre tested in practice.

It is rather important to give a simple name to any new fibre, and might I suggest that you call your new fibre Pusa fibre or Pusa jute. I understand the Watson press is now being constructed in Calcutta."

It will be observed that the report lays great stress on correct and thorough retting and on the importance of this in connection with manufacture. The thoroughly retted Pusa sample was valued at £18 a ton, while the local variety, retted by the people, was only worth £8. This valuation will serve to draw attention to the great increase in value of Indian fibres, such as Deccan and *sann* hemp, which would immediately be obtained if more care is taken in retting and in placing Indian fibres on the market in the most suitable form. This has been pointed out many times before, and the fact that a carefully retted sample should have made such a favourable impression on the brokers proves how low is the present standard of preparing Indian fibre for the European manufacturers. The plot from which the sample was taken was not heavily manured. It was a high-lying, well-drained field of rather light soil in quite good condition.

Arrangements have been made to grow Type 3 on several estates in Bihar and it is hoped, if these early trials are successful, it will be possible to send to London a consignment of this fibre for sale on the open market. Seed is available in the Botanical Section at Pusa in quantity and can be supplied at once to applicants.

AGRICULTURAL LABOUR AND WAGES IN WESTERN INDIA.

BY

G. F. KEATINGE, C.I.E., I.C.S.,

Director of Agriculture, Bombay Presidency.

It is a commonplace statement of a certain class of writers that the history of Western civilisation is the history of man's emancipation from the tyranny of his surroundings and that the history of tropical civilisation is the record of his enslavement to them. Americans in particular are prone to make such statements; and it is perhaps natural that they should do so, contrasting the enormous and rapid development that they have effected in their own country with the stagnation which they found in such naturally fertile countries as Hawaii and the Philippines when they assumed the rule of those islands. Perhaps they are apt to minimize the part which the great physical advantages of their own country have played in this development, and the almost unique opportunity which was presented to the handful of men who divided up a continent amongst themselves. Still it was not without a severe struggle that they entered into their heritage and turned it to such good account, and we may forgive the complacency with which they regard their handiwork.

While, therefore, we may deplore the physical poverty of a tract like the Deccan, we may solace ourselves with the recollection that a civilisation which is based on natural advantages and not on the energy of man contains within itself the seed of its own destruction. The land may be good or bad, and the plough may be good or bad, but it is the man behind the plough who counts

for most in the long run. Let us consider the progress of his struggle with nature in the Bombay Deccan.

The picture of the tropical cultivator leading a life of contented indolence, his simple wants supplied by a bountiful nature, has no relation to the conditions of the Deccan with its thin layer of soil and its light and capricious rainfall. The Deccan picture would rather represent a perpetual struggle in which the cultivator has frequently found himself on his back. The early years of the 19th century saw desolation in the land, and the last years of the century saw this calamity averted only by elaborate administrative efforts. So far the victory has been with Nature, and the Famine Relief Code, while it secures the best terms for the vanquished, affords evidence of the defeat. If, therefore, we hold that Nature can smother her favoured children with too much kindness, we might expect that the niggardliness which she displays to her step-children in the Deccan would brace them to strenuous efforts. In part this is so ; but the struggle has been too severe for many. Without its essential equipment the bravest army cannot expect victory, nor can its *morale* survive constant defeat. So it is with the Deccan cultivators, many of whom have neither the equipment nor the confidence that lead to victory.

Let us examine the position of the Deccan cultivator both as a small proprietor and as a hired labourer, and see how he has been influenced by the changes of the past half century. In the first place, let us consider the rise in wages which has occurred and the so-called "scarcity of labour" about which we hear so much nowadays. There is no doubt that wages have gone up largely and that even at the higher rates labour is more difficult to obtain than it was a short time ago. Landlords and the larger farmers who employ labour all tell the same tale, and usually add that the labourers work shorter hours and are more independent than they used to be. Other employers such as contractors and Public Works Department officers generally confirm this statement. The explanation commonly given is that the population has been reduced by plague and that the new industries have caused a greater demand for labour and attracted the best workmen to the towns. These

considerations are not negligible, but are they sufficient to account for the change? If we turn to the statistics of the Central Division of the Bombay Presidency we find that between 1890 and 1910 the population increased, in spite of plague and famine, from 6.211,000 to 6,389,000 while during the same period the number of factory hands in that division rose only from 8,000 to 34,000 and in Bombay City from 60,000 to 133,000. Even assuming that all the Bombay factory hands are drawn from the Central Division, is it possible that an extra demand for 100,000 workmen, accompanied by a rise of nearly 200,000 in the total population, could double the wages of a population amounting to over six millions? Even admitting that commercial developments and public works have recently made larger demands for labour, can we attribute the rise in wages mainly to these causes? Surely not. In some tracts where hardly any of the population leave their villages in search of work, employers of labour state that they can often hardly get workmen for 8 annas a day even in the hot weather when field operations are at a standstill. What then is the true meaning of the rise in wages? The fact is that since the Indian farmer has had access to the world's markets, agricultural produce of all kinds has gone up greatly in price, and as the bulk of the population have such produce to sell they are now better off than they used to be. They have used this increase in their wealth partly in buying more necessaries and luxuries, and partly in doing less work. Wherever one goes, one is told that whole classes of people who formerly used to engage in field work now employ labourers to do the work, and themselves merely superintend it. This is said of the Patidars in Gujarat, the better class Lingayets in the Southern Maratha Country, the Havigs in Kanara and of the more substantial cultivators everywhere. So also with the smaller proprietors. Many a man who formerly supported himself on his holding during part of the year and was glad to work for hire in the off season now finds that he can get on without the latter source of income, and keeps out of the labour market altogether unless exceptionally high wages in the neighbourhood of his home tempt him to forego his hot weather holiday. Even in years of scarcity there now seems

to be no demand for work at famine wages. In one way this is satisfactory, in another way it is not so. We may rejoice that the *raiyat* no longer lives in the "hand to mouth" condition of former days, but would like to see him use his advantage to strengthen his position. The victory is not yet won, and he cannot afford to stand still while his rivals in other countries are progressing. If each economic advantage gained is to be the signal for a relaxation of effort, if improved methods of farming are to serve not only to increase the crop but also to swell the ranks of the non-workers, is any marked progress possible ? The question is one which will repay consideration, but in propounding the question it is not intended to suggest pessimism. The economic position of the labouring classes in Europe has greatly changed for the better during the past century, and they have used their advantage in part to reduce the hours of labour. Few people will contend that incessant labour is in itself a blessing ; and when a man has satisfied his necessities he will fix the limit up to which he is prepared to work with reference to his desire for more than the bare necessities of life : in other words in accordance with his standard of comfort. The standard of comfort of the Indian peasant is low, and his training teaches him to be content with little ; but there is clear evidence that the standard of living is rising.

Apart from the incentive to labour we have to consider the question of vital energy, which differs with individuals and with races. The Deccan peasant has been accustomed to periods of enforced idleness, to conditions of intermittent labour ; and there can be little doubt that irregularity of labour produces bad results, including a condition of apathy and helplessness which, being transmitted through centuries, acquires the rigidity of a race characteristic. It is probable that a rising standard of living and increased facilities for obtaining remunerative labour will in future do much to correct this. At present, however, the tendency of the cultivator to relax his efforts, the moment that his circumstances permit such a course, does much to discount the advantage which the relatively high prices of agricultural produce have brought to his door.

A small American farmer with an irrigated holding of (say) twenty acres may be worth a lakh of rupees, but he not only works on his land himself, but frequently does the whole of the work, his hours being from sunrise to sunset. The American holder of somewhat less means will not disdain to work for hire as a navvy in any spare time that he can filch from his farm, and will thus provide himself with additional capital for developing his land. In this country does any farmer worth Rs. 20,000 engage personally in field labour on his own farm, or does any farmer worth Rs. 5,000 employ his spare time in working for hire ? Such instances must be very rare. In India the natural tendency of such men is to engage low paid labour for the more exacting part of their current field operations, and to finance any permanent improvements that they may contemplate by means of a loan. It is the heavy bill paid for ineffective labour that runs away with the profits of the substantial cultivator. It is this that he has to keep down ; and the best way that he can keep it down is to work himself and to work with effective implements.

The chief ground for optimism lies in the fact that in the more favoured regions of the Deccan substantial cultivators with means of irrigation and with suitable holdings are extremely hard-working and continue their labour throughout the year. Their equipment is none too good, but their industry will compare favourably with that of the farmer in most countries, and presents a marked contrast to the short hours of labour in the cotton tracts of the Southern Maratha Country and to the long period of inaction of the Khandesh cultivator whose fields lie bare from December to June. We need not seek to condemn the cultivator to the excessive labour of the Japanese husbandman who slogs away in his field from morning till night with a heavy hoe, and treats each plant to separate doses of liquid manure ; but if we can, by mastering the productive forces of nature and improving the economic organization of the cultivator, provide him with more constant and more remunerative work, we may leave it to the rising standard of comfort to induce him to undertake it.

In localities where low-paid labour is still available, as in the Bhill tracts of Khandesh, every substantial cultivator, and many

who are not substantial, will keep at least one *saldar* (yearly labourer) to relieve him of the drudgery of his work, though he may own only twenty or thirty acres of dry-crop land, and is accustomed to engage temporary labour at the busy seasons. In such localities it will be found that wherever there is an irrigation well there is a *saldar* to work it, and that such improvements as the construction of field embankments or the cleaning of land by hand-digging are carried out, if undertaken at all, entirely by hired labour. Little efficiency is expected from this "cheap labour," and consequently there is a tendency in such places to assert that irrigation wells are not profitable, and that permanent improvements do not pay. The cry nowadays is that owing to the rise in wages the position of the cultivator who has been accustomed to trust to such cheap labour has become very difficult. The onlooker may feel inclined to say—"would that it were impossible." If the wages for field labour were to rise to Re. 1 a day, the small landholder would probably see the advantage of performing for himself much of the work for which he now pays wages, and his labour bill would go down instead of going up.

Such changes do not take place in a day, and any talk of American standards may at present appear to be futile; but it may be helpful to consider the opposite extreme which can be found at our own doors. In the Thana district a man who wishes to engage a daily labourer goes to the hut of a Warli or Katkari and asks the man's wife whether they have sufficient *nagli* (*Eleusine coracana* their ordinary food) for the day. If she says "yes," he passes on to the next hut.

SUGAR AND THE SUGARCANE.*

BY

C. A. BARBER, Sc.D. (Cantab.)

Government Sugarcane Expert.

THE economic effects produced by the present disastrous war are full of surprises, and it will probably take years after its conclusion before the dislocation of trade is healed and a fresh equilibrium established, and commerce runs smoothly along its new made channels. Who would have thought that one small cruiser was capable of paralysing for a time the trade of India? And who could have prophesied, at sowing time, the rapid fall in prices of jute, groundnut, cotton, san-hemp and other staples, bringing hardship on millions of our cultivators and merchants?

Sugarcane in India is less affected. We are largely self-contained, and the enormous quantities of its produce required by the people of the country as food are mostly available within our own borders. We grow and manufacture almost all our own sugar but, unfortunately for us, we go no further, and there is no longer any export trade. If there were, here at any rate the prospects would be of the brightest. There would be an enormous boom in production, as a set-off to the decline in many other agricultural products.

One of the most interesting of the many measures, undertaken by the present untiring British Government to meet the crisis,

* Extract from the opening address in the Botanical Section of the Madras Science Congress of January 1915.

was the purchase, during the first few weeks after the outbreak of hostilities, of one million tons of cane sugar. Startling times produce heroic measures and the ultimate effect of this action cannot at present be correctly gauged, but the net result is that the British nation need be in no immediate fear of a famine of one of its most valued articles of diet. In order, however, to understand this action on the part of Government, it will be necessary briefly to study the world's production of sugar and the sources from which Great Britain usually obtains its supplies and, further, to enquire into the nature of the substance itself. Is sugar a necessity of existence? It is inconceivable that, at such a time, the Government should have taken such a measure merely on behalf of a luxury.

In the map opposite, the world's sugar production during 1913-14 is shown, the quantities produced in different countries being indicated by circles of different sizes. There are two kinds of circles, solid ones and rings, and these refer to two different classes of sugar. The rings, being in the temperate zone, represent beet-sugar, while the solid circles represent cane sugar and are nearer to the equator. Germany, Austria, France, Russia, Holland, Belgium, Italy and the United States are the sources from which the world obtains its beet-sugar—a list of countries which at once arrests the attention. India, Cuba, Java, Hawaii, Louisiana, Mauritius, Porto Rico, San Domingo, Queensland and Fiji, Peru, the Argentines, Brazil, Egypt, Natal and the West Indies and Demerara, on the other hand, are the chief places where the sugarcane is grown. Now it will be obvious at a glance that, while the second series are in no case actually disturbed by the war, almost all of the countries in the former are, at the present moment, overrun by hostile forces or support great standing armies. It is the beet-growing countries of Europe that are affected by the titanic struggle now going on and their sugar-making provinces are the actual arena of the fight.

The following table gives Great Britain's imports of sugar during 1913, with a list of the chief countries from which it is drawn, as well as the relative quantities of beet and cane sugar used.

A.J.I. Map 1.—Showing the world's production of sugar in 1913-14. The solid circles refer to cane sugar and the rings to beet-sugar.

Sugar Imports into Great Britain during 1913.

(Countries sending over 100,000 tons.)

	Tons.	
Germany	938,438	Beet.
Holland	190,166	Beet.
Austria	359,469	Beet.
Cuba	223,980	Cane.

Total Imports.

Beet sugar	1,571,430	tons.
Cane sugar	564,760	,,

We see at once that beet occupies a far more important place than cane, and that the war has completely dislocated the British trade in this commodity. Let us study the position of the beet industry on the continent. Germany is the principal normal source of sugar supply to Great Britain, but she is now our enemy and not one pound of sugar can enter the country. She will have to consume her own sugar, and the report has gone abroad that Germany will store some two million tons as a reserve for the future. It remains to be seen what will be the ultimate fate of this enormous stock. Austria's quota again is unavailable, and it is not clear how the enormous demands she is making on her male labourers will affect the digging and manipulation of the roots. France is our ally and, although not usually sending much sugar to the British market, would probably be quite willing to let us have a supply. But the French districts where the beet is grown happen to be exactly those recently overrun by the Germans in their rush for Paris. It is safe to assume that the great bulk of the crops have been ruined, and there are many statements tending to the belief that the Germans have made a point of wrecking the machinery in the sugar factories, and they are even reported to have dug out the roots and sent them to the German factories to be worked up into sugar. France, then, cannot supply our needs. Belgium may be ruled out altogether. Russia can produce great quantities but, by agreement, she does not export beyond a certain amount, and the sowings were presumably made under that condition. Besides, it is difficult to see how, as things are at present, she can send sugar to Great Britain except through

Sweden or by the long route across Siberia. Holland is guarding her own supply, while in Italy there is a short crop this year. To sum up, then, practically the whole of Britain's usual supply of sugar is locked up.

There is thus no doubt that the British Government was justified in feeling considerable alarm as to its future sugar supply, and the heroic measure, of suddenly diverting a large quantity of the tropical supply from its normal trade route, would appear to be justified. But is sugar so necessary? Is it so vital to our national well-being? When any family passes a self-denying ordinance and decides to give up some luxury because of bad times or for the good of foreign missions, the first thing done is to "cut off the sugar." Does not that imply that the British nation, now curtailing all unnecessary expenditure to meet increased taxation, can very well do without its sugar? Let us consider this substance more closely.

Sugar may be succinctly described as an easily digestible carbohydrate, muscle feeder, warmth producer, the cheapest of substances rendering others palatable and therefore best taken in combination, of special value for children, a gentle stimulus to appetite and a powerful aid in checking the craving for drink. It is particularly suited as a food for workmen doing heavy work and all engaged in active exercise. It is concentrated, and excess induces dyspepsia, and it is inadvisable in connection with all diseases caused by excess of uric acid in the blood.

For thousands of years it has been recognized as a valuable food in the east, but, in the west, it is only within comparatively recent years that it has been treated otherwise than as a luxury, as is shown by the consumption in Great Britain in 1700, 1800 and 1900.

Increase in sugar consumption in the British Isles.

1700	10,000 tons.
1800	150,000 „
1900	1,560,000 „

The British have always, as a nation, consumed more sugar per head than any other European people, as is seen from the accompanying figures (for 1895). Consumption per head of population,

Great Britain—86lbs., The United States—63lbs., France—31lbs., Germany—27lbs. Is this correlated with the love of "sports," that violent exercise, without meaning to peoples of less energetic nature ?

Let us expand this idea. Sugar is not a luxury but an indispensable food. A writer, in a paper in the Proceedings of the Royal Society, gives the results of experiments with it, and shows that an added ration of sugar has a great effect in retarding fatigue. He shows that four times as much sugar is consumed by the body during muscular action as when at rest. An additional 8 ounces of sugar to the normal ration increases the power of work during an 8 hours' day by one-fourth to one-third. Muscles in action reject any other food and consume sugar only, and if other food, such as meat, is provided, a considerable amount of work is thrown on the body in breaking it down and extracting the sugar which it contains. Many ingenious arrangements have been invented to establish these facts, but perhaps the most interesting of these "ergographs" is an immense inclined plane, part of which revolves through a specially shut-in room. In this room men and animals are compelled to walk up the inclined plane to prevent their being crushed against the wall, and all their food and excreta are estimated, even to the air taken in and the gases given off by their skins. In walking up the inclined plane constantly revolving in the opposite direction, the animals remain stationary, and the amount of work done, depending on the rate of rotation, can be accurately determined. Incidentally, an interesting discovery has been made by this contrivance, namely, that the animal mechanism throws all others into the shade in efficiency. The work done by the human machine, for instance, was found to be 33 per cent. of the food value, whereas in the steam engine it is from 5 to 20 per cent. of the fuel used. No wonder that the constant activity of childhood craves for interminable supplies of sweets. No wonder that our soldiers in the South African war were supplied with large quantities of jam and sugar with their rations. We read that the North American Indian, when on the trail, used to reject all impedimenta except a drinking horn and a

small packet of maple sugar. When he came to a stream, he filled his horn with water and shook a little sugar into it and, after the draught, went on his way. This is in rather striking agreement with the experience of Sir Ernest Shackleton, on one of his expeditions when the temperature fell to 62 degrees below zero. "Sugar," he writes, "has proved a great life preserver and sustainer in Arctic regions. On one occasion we had to march 321 miles in 14 hours dragging laden sledges. Every hour we took 2-3 lumps of sugar each. Within ten minutes of eating this, we could feel the heat going through our bodies,"—this heat presumably being caused by the feeding of the muscles on the sugar. But it is unnecessary to multiply examples. Indeed it seems likely enough that our high national requirements of sugar will be exceeded in the present war, and that the foresight of the Government may be of greater consequence in the fighting line than is generally supposed.

The dislocation of the world's sugar trade is a very real thing, and it is a curious circumstance that, throughout its history, the sugarcane has ever thus been connected with war and strife and oppression. Let us briefly consider the origin and migrations of the sugarcane.

The original source of the sugarcane is lost in obscurity, and nowhere in the world has the wild plant been met with. We can only therefore approach the question indirectly, by the study of tradition, philology, history and the general conclusions of botanical investigation. It is recorded in the sacred books of the Hindus that a certain famous Raja of olden time aspired to share the abode of the gods during his lifetime. This being denied him, he employed a celebrated magician to make things as pleasant below as possible. The hermit formed a paradise on earth and stocked it with the most marvellous plants. Later on, the quarrel was healed and the garden was no longer of any use. The paradise was destroyed but, as a memento of the magician's skill, the gods threw down some pieces of sugarcane for the mortals to grow. Thus the sugarcane emerges from the womb of the past owing to an ancient quarrel. There is no historical record of the origin of the sugarcane. To all appearance it was known in ancient India, and it is an interesting

fact that, while all the names for the plant to the west of the Indus have a common root in the Sanskrit "sharkara," it is known to the east of that river by numberless words, arguing a much more ancient record there. There are references to it in the most ancient of the Hindu books, while its introduction into China is definitely stated as being from India, and its migration to the west is comparatively recent. Botanically, the evidence is that it has arisen either in India or in the islands of Polynesia. The map of the world will be useful in following its migration within historical periods. Alexander the Great found it in India and carried it away with him in the 4th century B. C. It subsequently became established in Persia and, later on, when that country was conquered by the Arabs, they took it to Egypt and Syria. In the beginning of the 8th century the greater part of the fertile land in Egypt was under sugarcane. The Moors, in their westward course along the north of Africa, carried it with them and, when they conquered Spain they established it there, and it is of interest to note that this is the only place where it now has a foothold in Europe and that some 10,000 tons are produced annually in Spain. Wherever the crusaders went they were much impressed by the sugarcane. and its knowledge was thus widely spread over western countries. This led to a famous market being established for sugar in Venice, to which the sugar was brought from Syria, Egypt. Cyprus and Sicily. It is recorded that a Venetian was awarded 100,000 crowns for discovering the way in which to make loaf sugar. But, in the 15th century, this celebrated mart was ruined by the long continued wars with the Turks, who, although unable to conquer Venice, cut off the supplies. But it was meanwhile carried by the Portuguese along their colonizing route to Madeira and thence to the Canaries, and it is stated that it was produced in such quantities in these islands, that the price fell rapidly and that sugar came into more general use, in place of being a rarity used chiefly in the prescriptions of physicians or in the houses of the wealthy. A further and much more important change took place when Columbus discovered America, for he carried the sugarcane with him, and introduced it into Brazil and the West Indies.

A.J.I.

Map 2.—Illustrating the origin and migrations of the sugarcane.

The plant throve wonderfully in these tropical parts and, finding that the native Caribs (that is, such as were left after their ruthless destruction) were unsuited to fieldwork, the Portuguese and Spaniards brought over the Africans whom they had employed in Madeira, and thus founded the West Indian slave trade. Being produced cheaply by this slave labour, the price fell enormously and the industry waxed exceedingly. All other sources were rendered of no account and, when the British took the islands from the Spaniards they took the slaves with them. For many years the industry was connected with this cruel oppression and the British Colonies grew in wealth and power.

The connection of the beet-root with sugar is of much more recent origin. The plant itself is found wild along the shores of the Mediterranean and the Greeks knew it as a spinach and salad. ················It was not till the end of the 18th century that it was found that quantities of sugar could be stored in its roots. This fact was seized by Napoleon and made the most of. He was persuaded that England owed her greatness to her colonies, a mistake that has been repeated since then, for it was rather her restless energy which had given her her colonies. Napoleon barred all colonial sugar from the European markets, and a great series of bonuses were granted to any one who made sugar from the beet-root. Thus was started the beet industry which, receiving a check when Napoleon was overthrown, ultimately secured a firm hold about 1830, and made great strides from 1840 onwards to the present day, especially in Germany, France and Austria. The sugar wars of recent years have been largely economic, but they have merely been a continuation of Napoleon's brilliant inspiration. The fight has been between the sugarcane and the beet-root. By the action of fictitious aid in the shape of bounties, it looked at one time as though sugarcane was doomed, in fact, 20 years ago, beet had passed sugarcane, as is seen from the following figures :

	1894-95.	1895-96.
Beet	4,792,530 tons.	4,323,899 tons.
Cane	3,387,461 ,,	2,652,000 ,,
Total	8,179,991 tons.	6,975,899 tons.

A. J. I.

Map 3.—Showing the world's production of sugar in 1894-95. The solid circles refer to cane sugar and the rings to beet sugar. The asterisk indicates maple sugar.

But, since that time, the application of science to the fields, better management, the formation of larger estates with greatly improved machinery under strict chemical control, coupled with the introduction of better kinds of cane, have resuscitated the sugarcane industry and placed it finally on a secure basis. The battle continues, and it remains to be seen what will be the outcome of Germany's attempt to corner the beet sugar of the world. She has, let us hope, failed, like Napoleon, in her daring desire of depriving England of her colonies, and for a similar reason.

It would probably take us too far to deal with the intricate subject of sugar bounties, granted by European countries in aid of the beet industry. The leading principle has been to encourage the latter by giving premiums on all exported sugar, and paying for these premiums by taxing the consumption in the country itself, making sugar pay for sugar, taxing populace in favour of agriculture, the towns in favour of the country districts. This has led to some amazing incongruities as can be seen by inspecting the table, which gives the prices of the sugar in various European countries at a time when beet was most dangerous to sugarcane.

Consumption and prices of sugar in different countries.

	Consumption per head	Price per lb.	Cost per head per annum
British Isles	86 lbs.	1½d.	10/6
United States	63 ,,	2½d.	13/-
France	31 ,,	5	13/-
Germany	27 ,,	3	6/9

The English market has always been the main objective of the beet growers, and the results of competition for it can be easily seen in the table. Sugar could be bought in English country towns at less than a third of the price which had to be paid by the actual producers in the French sugar factories. The net result was that thousands of tons of valuable food were cast at Great Britain's door. Sugar was cheaper than manure, and Great Britain had no difficulty in capturing the jam and biscuit trades of the world. This, however, was only one side of the question. The sugarcane colonies practically went to the wall. Britain almost

ceased to import sugar from them, acute distress prevailed in the West Indian Islands, and several of them became bankrupt.

Imports of Sugar into the United Kingdom.

	1845.	1865.	1895.
Total Imports	6,000,000 cwts.	11,000,000 cwts.	31,000,000 cwts.
From British Colonies (Cane)	5,000,000	5,000,000	3,000,000
From Europe (Beet)	4,000	300,000	23,000,000
From Germany alone	...	30,000	17,000,000

Napoleon's dream was thus effected long years after his death, but the result was hardly what he had expected. The failure of Britain's sugar growing dependencies was a purely local affair and had little or no influence on the destinies of the Empire.

But, for the sugarcane industry, this failure was a very different thing. It is difficult now to understand how the cane growers were able to bear the strain and keep going until better times came round. Possibly the expensive machinery employed, and the large amount of capital locked up had something to do with it, for it is an undoubted fact that many estates were run at a loss for a considerable period. The rivalry of the sugar beet was, however, not the only disaster which overtook the cane industry at this time. The abolition of slavery was at one time thought to be its death blow, but a still worse danger threatened. Whenever a plant is subjected to intensive cultivation, it is merely a matter of time before this brings in its train serious epidemics in the fields. It would seem that the tendency is to strain the constitution of plants under cultivation, and thus render them liable to become delicate and the prey to the hosts of insects and fungi always on the look-out for suitable food.

The sugarcane has always been specially marked out as fair game for pests. In the first records of plantation work, we read of terrible scourges wiping out whole tracts of country, the pests causing this destruction belonging to the most various classes of the animal kingdom. These early accounts naturally never refer to fungus diseases, which no doubt also played their part in the havoc.

Thus, as long ago as 1756, we read of a destructive disease in the sugarcane fields of Jamaica called the "Blast." This also appeared in several other parts of the West Indies and, wherever there was an outbreak, whole fields if not the total crops of the estates were destroyed, the good plants being often burnt with the rest in order to stem its progress. This appears to have been a kind of aphis which, to-day, would only appear in ill-cultivated lands or neglected fields.

In 1760 we come across the "sugar ant" (*Formica omnivora*), which was specially abundant in the island of Barbados and some of the French colonies. These caused such destruction that it was gravely debated whether the hitherto prosperous island of Barbados should not be altogether abandoned. The French island of Martinique offered a million francs for the discovery of a remedy, and Grenada £20,000.

Borers appeared in Mauritius in 1848 and caused the greatest consternation. They tunnelled in the heart of the cane stem in all directions and rendered harvesting almost impossible, in that the canes fell to pieces and these pieces were of little value as regards sugar content. A similar infestation is reported in Bombay, where on the introduction of the Bourbon cane from Mauritius it was eaten out of the ground and totally destroyed.

In 1878 "rust" appeared in the cane fields of Queensland, and simply swept them bare. This was caused by a minute mite which at the present day is not infrequently found on cane leaves in India.

With the progress of science it seems curious that, later, sugarcane diseases appeared whose causes were less easy to determine. Thus "gumming" appeared in Queensland and its cause was not successfully determined. "Sereh" swept through the Java fields, and, in spite of thirty years' study, its origin has never been satisfactorily cleared up.

Finally, after some years of misunderstandings, we have come to the conclusion that the whole sugarcane world is affected by a fungus disease, the red rot, and this appears, as a general rule, wherever the ground is water-logged, and causes wholesale loss of

crops. This may be regarded as the chief Indian sugarcane disease and no direct remedy has been found for it. The climax with regard to red rot occurred in the West Indies some twenty years ago. Shortly before harvest, when the canes were full grown and there was a prospect of an abundant crop, they suddenly lost colour, the leaves faded and the canes rotted in the ground. The fungus was masked by certain others, as well as by minute beetles which eagerly attacked the fermenting canes, and for years the latter were credited with being the cause of the disease. (*The methods adopted to combat these diseases were then briefly traced, from the time when disease in the canes was met by solemn processions and votive offerings, through violent onslaught on the pests and the study of helpful parasites to the final adoption of a policy of replacement by immune varieties.*)

In sugarcane, all these stages have thus been gone through, but it would take too long to give a tithe of the examples which crowd upon one's mind. The method now generally adopted is to fight disease by replacing affected varieties by those which have been noted as more or less immune. Unfortunately, it has been found that it is just the best and richest cane which is most readily attacked. It is regarded, however, as the best policy to obtain a certain moderate return than a doubtful higher one liable to occasional serious loss.

Let us take an example of such work, and it is regrettable that we have to turn to a colony under a foreign Government for a suitable one. Great Britain has been tardy in appreciating the supreme importance of the aid which science can give to agriculture. Java, at one time, in as dangerous a position as any other country, set itself to work out this problem of cane disease, and has ultimately won its way to complete success. There is an additional reason for selecting Java, for, as we shall see later, it will be necessary to compare that country with India in considering any possible extension of our sugar-making industry. It is from Java that we import our main supplies of refined sugar, and the question will arise as to whether we can, in India, produce it as well and as cheaply as that country. Besides this, Java presents a fine example of the

application of science to agricultural problems and, lastly, there is a series of excellent summaries of the various steps which have placed Java at the head of the sugarcane industry of the day. (*Then followed a summary of work done in Java, for which readers may be referred to this Journal, Vol. VII, Part* 4, 1912, *pages* 321 *to* 323, *the sugar production in Java reaching* 1,345,000 *tons last year.*)

Replacement of the diseased canes by more resistant varieties is seen to be the keystone of Java's success, and the principal kinds now grown in Java are seedlings. For many years the cane was held to be incapable of producing fertile seed. This is the more remarkable because many eminent botanists have paid special attention to the subject both in the East and the West Indies. In all probability multitudes of seedlings have been produced year by year in favourable localities but, from some cause, perhaps their similarity to grasses, no one had succeeded in detecting them.

The arrowing or flowering of the cane is a very well known feature in tropical scenery, yet in the northern tracts of India it is of very rare occurrence. It is mentioned by Dr. Kobus, in his account of his journey to Saharanpur to obtain Indian canes for cultivation in Java, that he met with people who had never seen the arrows, and did not know in what part of the plant to look for them.

The discovery of cane seedlings appears to have been made by a planter in the island of Barbados who, in 1858, observed great numbers of seedlings, which he carefully reared but ultimately rejected because of the appearance of certain objectionable characters. In spite of authentic records of this fact, as well as the less certain statements regarding the discovery of cane seedlings in Java a couple of years later, the fertility of cane seed was again disputed and these observations were almost forgotten.

Natural seminal reproduction of the cane seems to be particularly favoured by the climatic condition of Barbados, whereas the reverse appears to be the case in Java. Soltwedel in the latter island made crossing experiments for years, besides carefully searching the fields, before he succeeded, in 1886 in proving to his own

satisfaction that he could thus produce hybrid canes. In Barbados, on the other hand, a search in the fields by Harrison and Bovell was rewarded by the discovery of many thousands of plants in January 1888. While in Java the results were not made public for several years, those of Barbados were quickly known all over the cane growing world and excited the keenest interest in the subject. In Barbados, Harrison and Bovell, in Demerara, Jenmam and Harrison have continued these studies, and to their valuable reports we owe much of our present knowledge on the subject. More recently, the whole subject has been more exhaustively studied in Java, where the importance of the crisis caused the foundation of laboratories and the employment of a large trained staff.

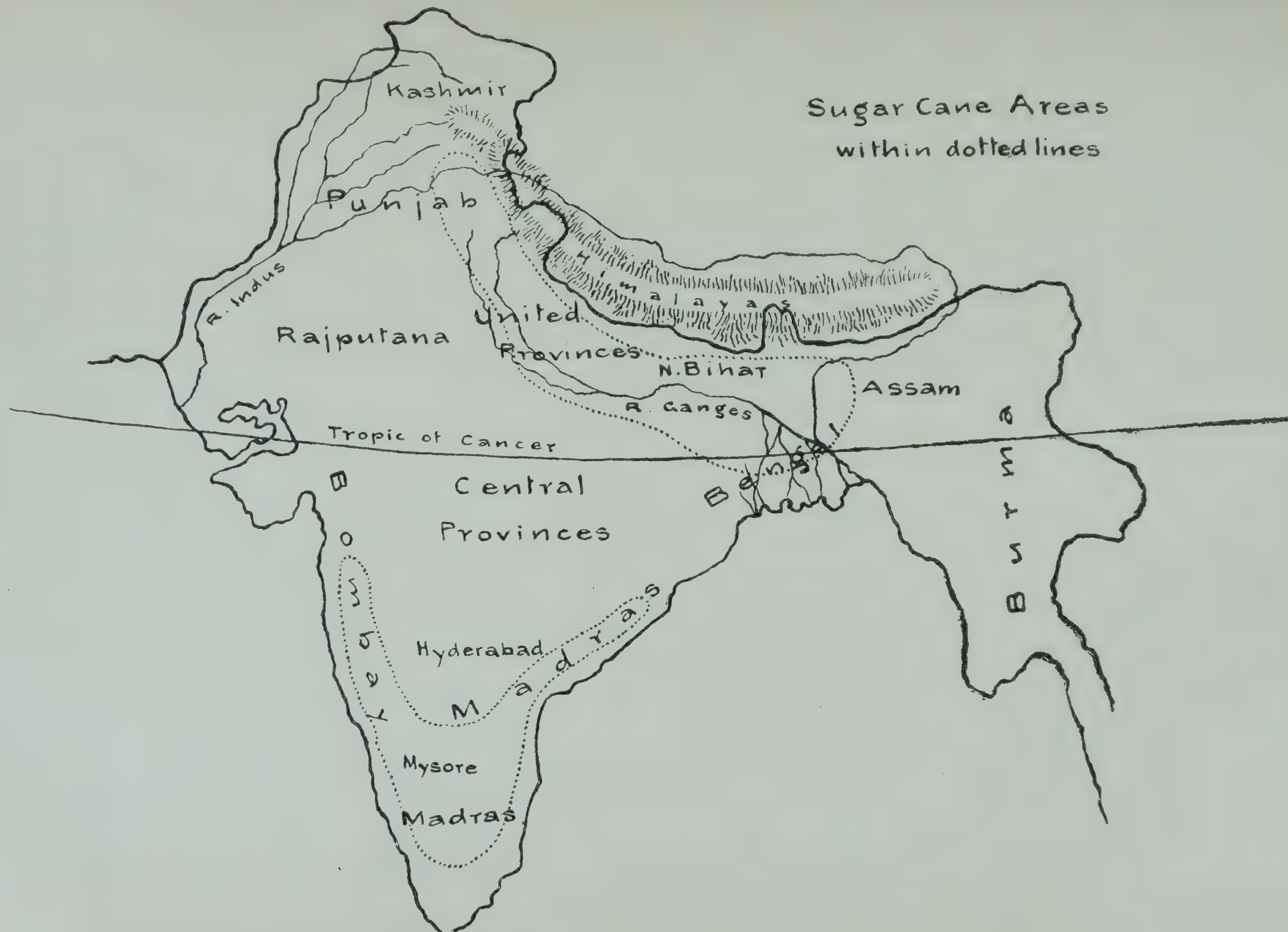
Many of the best canes in Java appear to have been obtained by crossing the old time Cheribon with the north Indian Chin or Chunnee of the United Provinces. We have the combination of a thick, juicy but effete variety with a thin backward fibrous one, with little juice but that of good quality and showing remarkable resistance to disease. To indicate the thoroughness of the Java work a reference may be made to the manner in which Java obtained the Indian variety. (*A short description of Dr. Kobus's visit to India was given and his work in acclimatizing Indian canes in Java. Chunnee seedlings were found to be immune to sereh.*)

We have now prepared the way for a consideration of the sugarcane problem confronting India at the present moment. While it ranks with Cuba as the greatest producer of cane in the world, there appears to be no special increase in production during recent years. While the world's production of cane sugar has nearly doubled in the last twenty years, that in India has if anything slightly receded. It will be necessary to find out a reason for this. Moreover, while in former years sugar was exported in some quantity from India to the British Isles, the last few years have seen a steadily increasing influx of foreign sugar, reaching last year not far from one million tons. The imports of foreign sugar have varied from time to time, partly due to the imposition in India of countervailing duties. Austria and Mauritius have in

times past provided the bulk but, in the present stage, it is Java that has come to the fore, and the great proportion of sugar entering the country hails from that island. The question is thus somewhat simplified, and we have to enquire whether we can or cannot enter into competition with Java for providing India's expanding market with refined sugar. There is a further point to be considered. It must not be forgotten that Great Britain is the only great country, which, while consuming large quantities of sugar, does not herself produce any. This fact accounts for the severe competition among sugar-exporting countries for her market. The experience provided by the present war has shown the danger of Britain's depending on other countries for its essential imports, and there is a general feeling that an effort will be made to obtain more of these from colonies or countries over which it has some control. Will the British Government deal thus with sugar and, if so, is there any chance of India's obtaining its share in supplying sugar ? To be candid, there is little hope of any such participation on the part of India at present. We are over a quarter of a century behind, and are only now tentatively commencing organized work on the sugar industry, and have not yet ventured to attack many of the intrinsic difficulties which will be apparent later on.

(*The cane growing tracts in India for the sake of clearness may be separated into two main regions.* (1) *Peninsular India and* (2) *the Indo-Gangetic Plain. The former is tropical and can grow excellent thick canes but water is a limiting factor and land is practically unfavourable. Cane growing is therefore not extensively practised, and less than one-tenth of the area under this crop in India is found in the region. The latter is outside the tropics, warmth is the limiting factor and the canes are very thin and small. It accounts, however, for nine-tenths of the sugar cultivation*).

Let us now turn to the position of the Java sugar manufacturer. He plants no canes and owns no land, but the climate is eminently suited for the growth of first class thick varieties, and water is procurable. Each factory has a definite zone in which it has complete rights regarding any cane grown. Government fixes the price at



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Map 4.—Indicating sugarcane areas in India.

which the canes are to be sold and, what is more important, decides what fields shall be under sugarcane. In fact the whole cultivation of the fields is under complete control, and the Government officials decide each year what crops are to be grown by the peasantry, thus ensuring an adequate supply of canes for the factory and a suitable rotation for the growth of sugarcane. Further, it is easy to arrange that the cane is grown in large blocks near the factories, and irrigation is accordingly well controlled. So far the action of Government. The laborious work of the large staff attached to the sugar stations has, during the last quarter of a century, provided the factories with a series of cane varieties of excellent quality, great resistance to disease, and suited to the varying conditions of the island. A comprehensive study of the soils and most profitable manures (the latter supplied by the factory) has enabled it to obtain the greatest possible amount of cane per acre, while the improvement in the factories has reduced wastage to such an extent that almost the whole of the sugar in the plants is rendered available for the market. There is, thus, the closest relation between the factories and government which, on the one hand, sees that the cultivators get a fair remuneration for their work and, on the other, that the manufacturer is kept supplied, at the proper moment, with the canes he wants. The key to the Java situation is **organization, complete government control in favour of the manufacturer and thorough chemical and botanical supervision in the fields and factory.**

It would take us too long to follow the history of the various ventures at founding sugar factories in India. The ruins of some of these may still be met with scattered over the country. The fact that India does not provide white sugar in sufficient quantities to take its place as a great exporting country is not due to lack of trials. But there is hardly a chapter in the annals of economic adventure that can record such uniformly unsuccessful results. Experienced planters have been brought from the West Indies and elsewhere, often carrying with them their favourite canes, and have exhausted themselves and their resources in the vain effort to force the West Indian practice upon the local soil and

climate. Managers have been appointed, with good business capacity, but no knowledge either of the factory or the field. In some cases factories have been started on a large scale with expensive machinery, without, however, a sufficient careful study of the local supply and demand, and have failed because they have been literally starved of canes, unless by paying prices incompatible with successful working. The price of jaggery or *gur* is in these cases the limiting factor. There has not been the slightest attempt at *organizing* the industry, and such sporadic efforts appear to me to be largely doomed to failure, excepting where local conditions are specially favourable.

But, with the general improvement in agriculture throughout the tropics, and especially with the founding of the Indian Agricultural Department, these mistakes seem less likely to be repeated, and there is some hope that the industry is entering on a brighter page in its history. It is, however, a curious fact that there seems to be more chance at the present moment of success in the less favoured northern region than in the peninsula. There are, no doubt, vast areas in Southern India where sugarcane of high quality can be successfully grown, but in the absence of any desire on the part of people to do this, is there anyone here who would advocate the introduction of the Java system of government control described above ? Without a somewhat perfect system of agricultural co-operation and very considerable improvements in manufacturing processes it would be idle at present to look for any great extension of the manufacture of sugar in South India.

Considering the industry as a whole, while India can perfectly well maintain her supply of jaggery whatever demands may be made on it, in sugar-making she is at present outclassed *in every single particular*, from the kind of cane grown and the methods of growing it up to the manufacture of the finished product. There is, to be sure, all the wider field for improvement, but it will probably be a long and weary process. It is not, humanly speaking, possible for one worker to attack the problem all along the line and, while others are engaged in attempting to improve the manufacture of the produce, it has fallen to the lot of the author of this

paper to undertake the improvement of the kind of cane grown. Here, at any rate, there would seem to be some chance of success. We want better, richer canes, with larger outturn in the field, greater resistance to disease, and yet adaptable to the methods of cultivation adopted by the cultivator. Improvement in the last particular will only be likely to come, if the variety of cane provided is more worthy of intensive cultivation.

There are several ways in which the improvement of the Indian cane varieties may be attempted. An effort may be made to select better strains from the existing varieties grown. Canes of better quality may be introduced from countries where scientific work has been carried on for years. Or, lastly, the production of seedling canes, which has worked such a revolution in Java, may be tried in India also.

The first two methods have been continuously exploited in various parts of India for centuries, but the first organized effort in them was made when the Government of Madras decided to found a sugarcane station at Samalkota, because the sugarcane industry in the Godavari district was threatened with extinction by the disease in the canes. This turned out to be our old enemy—the red rot, and the main work of the farm was to produce varieties immune to that disease. A number of local canes were got together and these were tested, side by side, with others introduced from various countries, especially Mauritius and Barbados.

The result appears to have entirely justified the Government action, and a number of good imported canes have been added to our list, which are now grown from one end of India to the other. It is interesting to note that the success of these introduced canes varies a good deal with the locality. It is in some places the *Red Mauritius* that has replaced the local kinds, in others the *Ashy Mauritius* is the best. In one tract a *red sport of the Striped Mauritius* is looked upon most favourably while in other places various *seedlings* from Java, Barbados, Mauritius are considered the best. But, although one or other of these canes has won success on almost every government farm where they have been tried, there is no doubt that, as a whole, the tropical canes are not suited to the

northern tract and the *raiyat's* method of cultivation carried on there. The tropical thick canes, needing good cultivation and heavy manuring, are often out of his reach for lack of the means to grow them properly.

What is needed is a more hardy type of cane, capable of holding its own with the canes grown *under field conditions* in the northern area. Such types are not usually available among the canes grown in tropical countries, and the only way to get them is to produce them ourselves. This has led to the founding of a Government farm where the main line of work is the production of seedling canes. Coimbatore has been selected as its site, because it has been noted that the canes growing there regularly flower every year.

Many efforts have been made from time to time in India to raise cane seedlings, but with uniform failure. This has been undoubtedly due to the lack of organized effort in the first place, and, secondly, to the fact that the flowers in many parts of India are infertile. The first success of the new farm has been to clear the way for the production of seedlings and, during its first three seasons, over sixty thousand have been raised.

If one examines sugarcane seedlings raised in India, it is evident at once that there is an immense variation among them, some of them looking like weeds or grasses, while others are equal in size and appearance to anything grown in the tropics. The preliminary analysis of the juice extracted from them shows as great variation, different seedlings yielding from below 10 per cent. to above 20 per cent. sucrose in the juice. Now, it is obvious that, in this very divergence, lies our hope of ultimate success. It is fair to assume that, as in other countries, there will be similar variations in field characters and resistance to disease. It may indeed be asserted that our ability to create good new canes suited to their environment will depend entirely upon the amount of time spent in the tedious process of selection. But India cannot expect to be able to do in five years what it has taken Java and the West Indies a quarter of a century to accomplish. There are intrinsic difficulties in India not met with in the tropics, while, on the other

hand, there is every prospect of our results being accelerated by the accumulation of experience gained elsewhere.

From a careful study of North Indian canes in their various localities it has become plain that it will be next to impossible to produce any one variety which will be equally at home in all parts of the vast area of the Indo-Gangetic plain. This idea has strong support in the very varying success of the introduced canes in different regions, as noted above. The canes of the Punjab would not be tolerated in Bengal, nor would those in Bengal grow at all in the frost-stricken plains of the north. A series of seedlings must therefore be evolved, each one specially fitted for the particular region where it is intended to replace the local kind. There seems to be only one way in which this can be attempted. In each case, first select the best local kind, accustomed for centuries to its peculiarities of climate and treatment, and cross it with richer southern varieties, so as to combine its resistant properties with the imported richness and bulk. The work is thus complicated, in that a series of separate problems have to be solved and a separate series of seedlings evolved for each geographical region.

The work of raising seedlings at the Coimbatore farm is now cut and dried, and it is not proposed to enumerate the many difficulties encountered and the way in which they have been overcome. It is now possible in any year to raise practically any number of seedlings. There are many causes for encouragement, and it is hoped that the Cane Breeding Station will fulfil its purpose and that, in due season, a succession of seedlings of approved parentage will be sent for trial to the different sugar-growing tracts of the country. ....

THE USE OF STEREOSCOPIC PICTURES FOR SCIENTIFIC PUBLICATIONS.

BY

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A STEREOSCOPIC picture is one in which things are so arranged that each eye of the observer receives a different impression, and these two impressions when combined convey to his mind the idea that he is looking at a solid object and not merely at a flat picture.

In making an ordinary picture, say a pen-and-ink drawing of a solid object, we may be said roughly to do two things :—to get the outline of the object (the boundary between it and the background) and then to show which of the parts are nearest to us and which are farther away. We do this, as a trial will show, *entirely* by copying on to our paper, by means of black ink-marks, the pattern of shadows which we see on the surface of the object. To realize this entire dependence on the shadow-pattern, the trial should be made by drawing some object about whose shape and "perspective" we have no preconceived opinions or familiar knowledge, such as an irregular chunk of earth or stone, a crumpled cloth, or a dinted lump of plasticine.

Anyone who makes such a trial will find, and easily understand, that when a surface is evenly illuminated all over so that it has no shadow-pattern, we cannot represent it in a drawing as being anything but flat.

Under ordinary conditions of working, the nearest approach to even illumination is got by sitting with one's back to the light and putting the object in front of us, so that the light falls on it from about the same direction as that from which we are looking

at it. A drawing made from this point of view will look flat, and will be a very unsatisfactory representation of any object of complex form and marked relief. It is noteworthy that the tendency to produce flat drawings by insufficient attention to this point, is a very common failing among Indian artists. To counteract it, special care should always be taken to arrange the object which is being drawn, in a position giving a shadow-pattern that will show up clearly the relief of the parts that are important.

To repeat, then, since in ordinary drawings or in photographs of unfamiliar objects, we have to rely for the expression of relief on shadow-pattern, it follows that no relief can be shown where shadow-pattern is absent. This latter condition is found especially in outline drawings and diagrams : it is impossible, for instance, to show relief in a geometrical diagram in pure outline such as Fig. 1. Moreover, it requires great skill and delicacy to make even a carefully shaded drawing show very high relief, and the limitation of tone gradation in the ordinary half-tone reproduction of a drawing or photograph makes it almost impossible to get much depth in the representation of objects which have some parts a good deal nearer the observer than others.

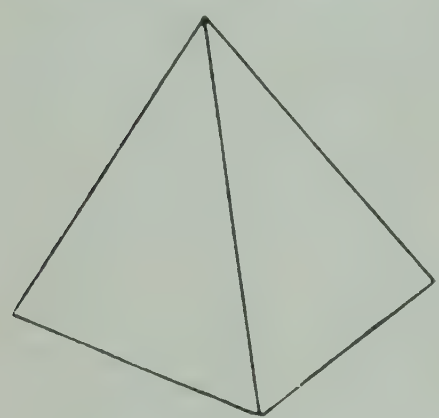

Fig. 1.

It will be readily understood that these difficulties are primarily due to the fact that we are attempting to imitate a three-dimensional impression, obtained by combining two two-dimensional ones, by a single two-dimensional drawing or print on paper. By combining the two drawings or photographs of a stereoscopic pair, however, we gain at once the full use of a third dimension with no restriction as to the presence or absence of a shadow-pattern.

Fig. 2.

For when we take two pictures (Fig. 2) one of them representing a straight line pointing in one direction, and the other a straight

PLATE XII.

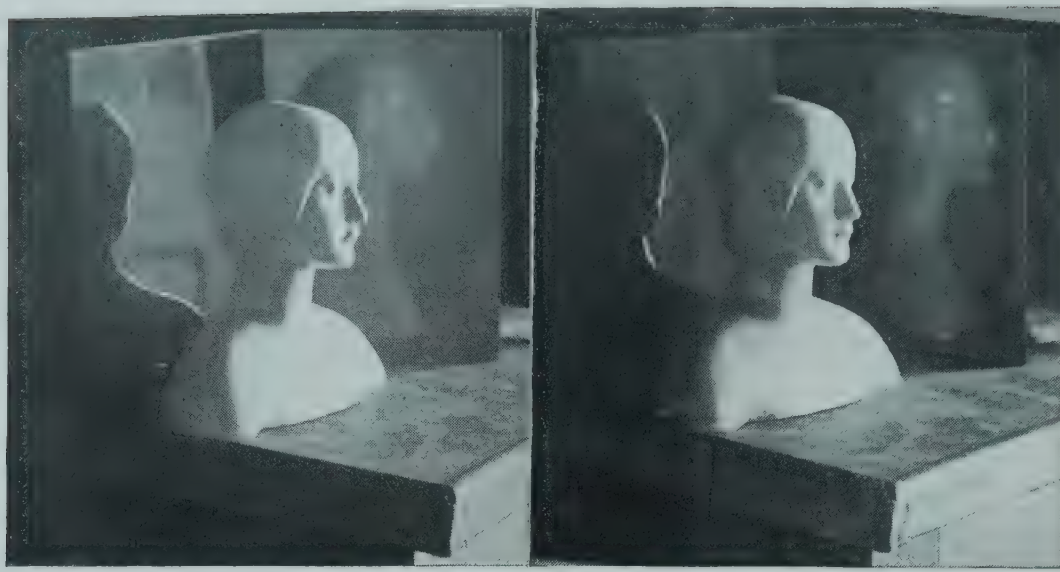

FIG. 1. PHOTOGRAPHS ARRANGED FOR LOOKING "THROUGH" WITH EYES RELAXED FOR DISTANT VISION.

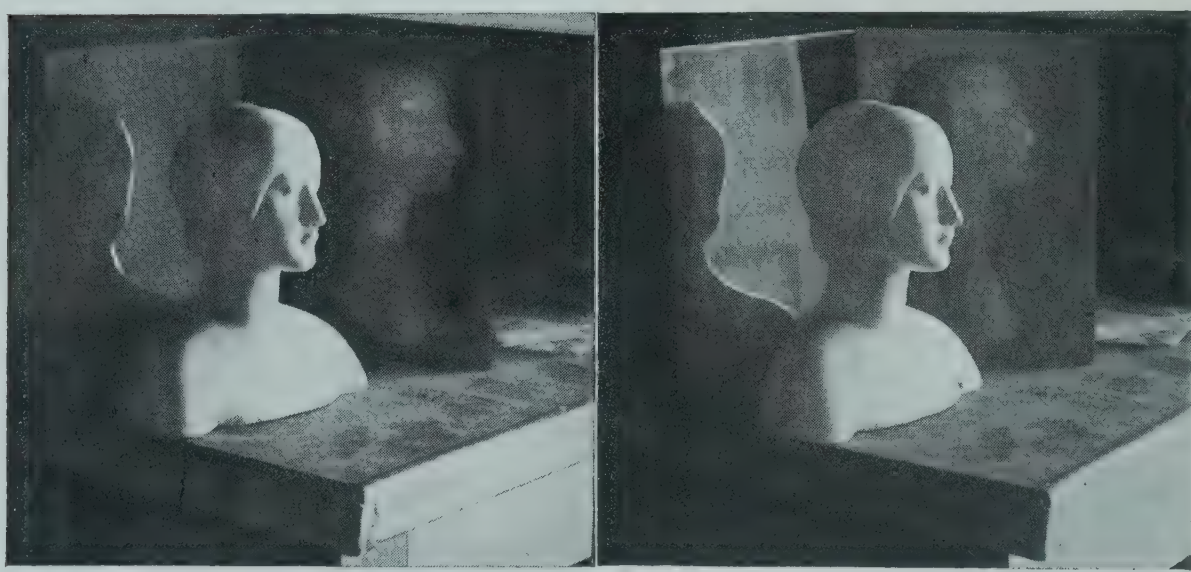

FIG. 2. ARRANGED FOR LOOKING AT WITH EYES CROSSED.

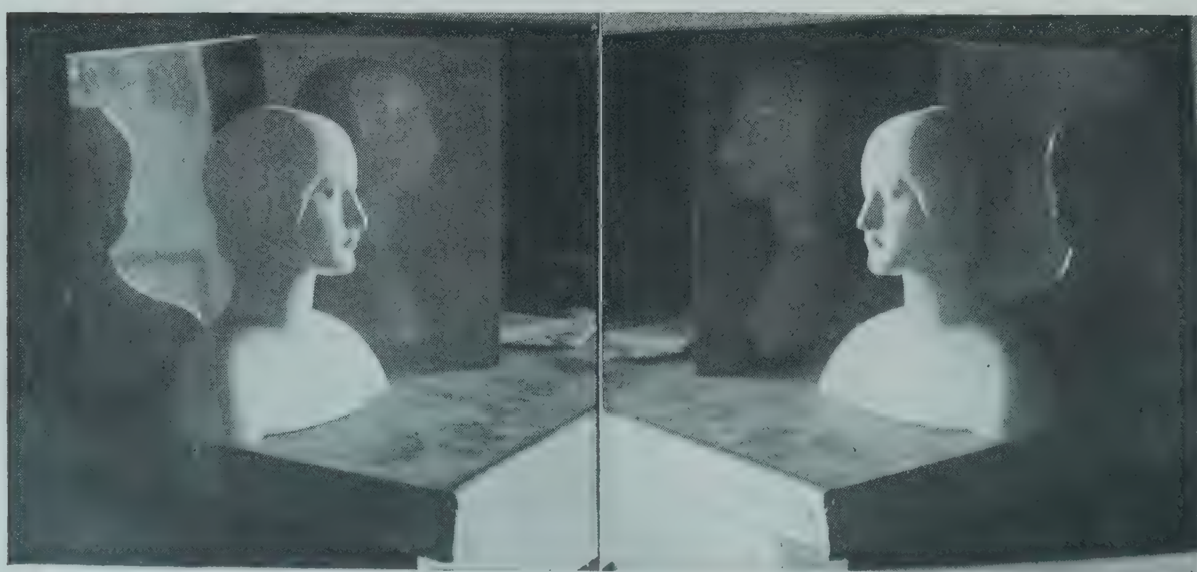

FIG. 3. ARRANGED FOR USE WITH MIRROR.

THESE BLOCKS WERE PREPARED AT SHORT NOTICE FROM INFERIOR PRINTS BY THE CALCUTTA PHOTOTYPE COMPANY WITHOUT ANY PREVIOUS EXPERIENCE IN THE WORK. BETTER RESULTS CAN BE GOT. BUT TO GET THE BEST IT WOULD BE NECESSARY TO EMPLOY THE COLLOTYPE PROCESS AS WORKED IN ENGLAND.

line pointing in a slightly different direction, and combine these two pictures into one, either with or without the aid of a stereoscope, we see a straight line with one end apparently raised above or depressed below, the plane of the paper. Stereoscopic pictures can thus show relief, independently of light and shade, in pure outline figures and diagrams, a thing which it is impossible to do by means of a single drawing or photograph.

We are all familiar with the ordinary stereoscope and the ordinary "views" which are supplied therewith for the amusement of the young, but the value of stereoscopic pictures for educational and scientific purposes has not yet been entirely realized, although there is one direction—the illustration of medical works on surgical operations—in which they are already largely employed.

The reason for this neglect probably lies in the increased cost of preparing stereoscopic photographs, and the much more serious objection that such photographs have to be viewed through a rather cumbrous instrument which cannot easily be carried about. The second objection can be completely met, while the first is not quite so formidable as it sounds, since the fact that a double photograph has to be made does not mean that the cost of reproduction and printing is thereby also doubled, as will be seen further on. With regard to the objection that stereoscopic pictures have to be seen through a stereoscope, many of those reading this article are probably able to combine such pictures without the use of any instrument whatever; and if they are not, it is not difficult to acquire a knack which is well worth learning.

There are two methods of combining pictures with the unaided eye. The first method (Fig. 1, Plate XII) requires only that the centre of the right-hand picture should not be more than about two to two-and-a-quarter inches from the centre of the left-hand one; that is to say, the two pictures must be printed side by side and each one must not be more than about two inches broad. Although they are small they can if necessary be viewed with an ordinary instrument. The second method (Fig. 2, Plate XII) requires that the pictures should be printed in a transposed position, the real left-hand picture on the right and the real right-hand one on the left.

There is practically no restriction on the size of the pictures, but they cannot be viewed with an ordinary instrument unless they are cut apart and the two sides transposed. To see by means of the first method, hold the pair of photographs (their centres say two inches apart) close up in front of the face in a good light, avoiding reflections from the shiny surface of the print. Make no effort to see them clearly, but look right "through" them at some imaginary point a long way behind them. A blurred picture will be seen between the two, consisting of the combined pictures seen by the right and left eye respectively. The pair of photographs should then be moved slowly away from the face to arm's length or less, the eyes being still kept directed as if to a distant point. After a little practice, or perhaps at once, it will be found possible to keep the eyes so directed, but at the same time to focus them for the distance at which the photographs are held, so that the combined picture will be clearly seen in sharp focus, and giving the impression of being slightly magnified. In the second method, the eyes are directed squintwise to a point half-way between the face and the photographs (which are held at a distance of a foot or two away), so that as in the first method a combined picture is seen as the middle member of a line of three pictures. If required, a pencil-point or a finger may be held to mark the approximate distance of the half-way point to which the eyes are to be directed, or still better a card with a suitably-sized window cut in it, and when there are seen three blurred pictures standing in a row, the photograph should be slowly moved forwards and backwards until (carefully keeping the direction of the eyes unchanged) the middle picture comes into focus, looking very sharp and brilliant but slightly reduced. By either method one should be able to explore the various parts of the picture at leisure and without inconvenience.

By reference to the diagram Fig. 3, it will be seen that whereas in the first method the right-hand eye looks at the photograph on the right of the pair, in the second method it looks across to the one on the left. Thus if an ordinary stereoscopic "view" (such as Fig. 1 of Plate XII) be looked at by the second method, one sees the curious effect of reversed relief, as though one were

looking at the back of a mask, in which a man's nose sinks into his face and his ears jut forward in front of his eyes. For the second method, it is therefore necessary, in order to get solid relief, to transpose the ordinary positions of the right and left-hand photographs, but against this it has the advantage that even very large photographs can be combined without difficulty.

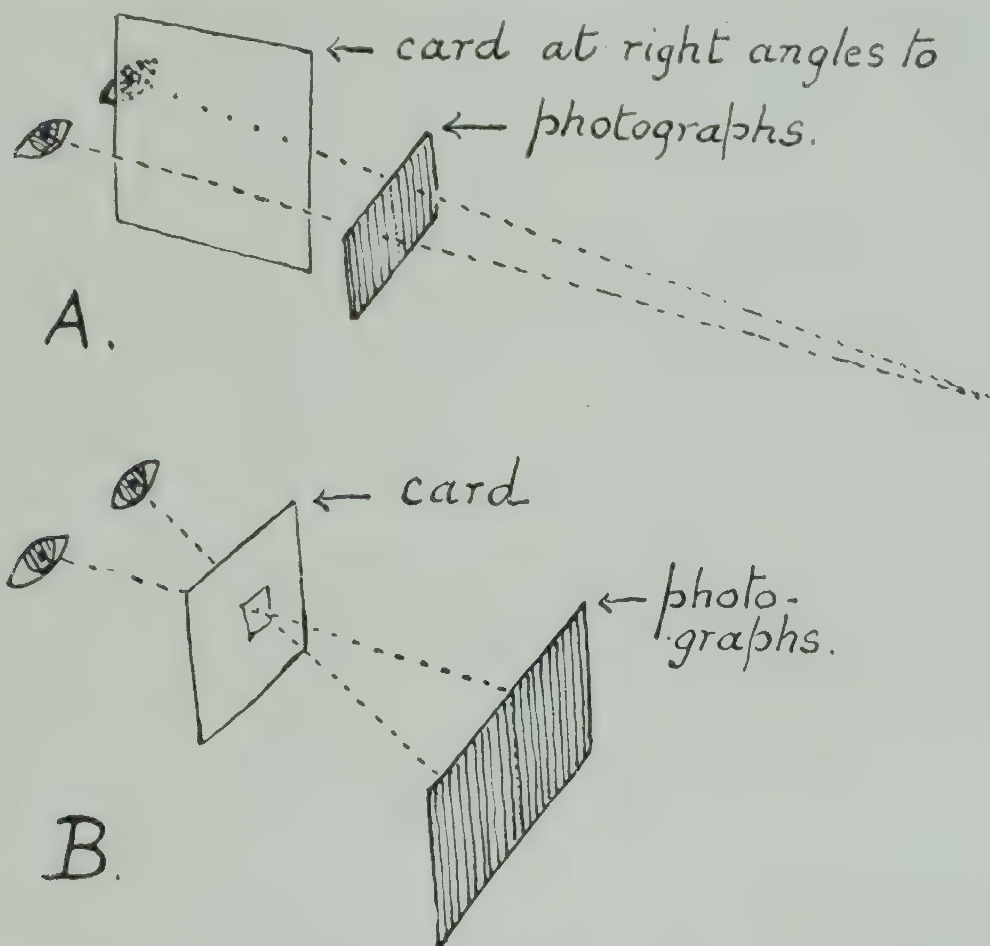

Fig. 3. A. First method; helped by holding a card between the eyes so as to allow each eye to see only its own photograph.
B. Second method; helped by a perforated card held so that each eye sees only one photograph through the hole.

To most people it is easy by either of these two methods to get a blurred picture showing a certain amount of solidity, but more difficult to get that picture into sharp focus and looking really solid as it should do. The difficulty is that we are so accustomed to focus our eyes for the distance which corresponds to the angle at which they are at any moment converging, that we do not at first find it easy to converge them on a point at a given distance, and at the same time to adjust their focus to some smaller or greater distance than this, as has to be done in the first and second method respectively. To help us in keeping the eyes at the proper angle

of convergence, it is often useful, as already mentioned, to employ a card or piece of paper as shown in the diagrams.

Against the use of stereoscopic pictures for ordinary illustrating it may be urged that every one cannot be expected to take the trouble to learn how to combine these pictures with the unaided eye, so that the objectionable necessity of having some form of stereoscope always at hand, when reading any work illustrated in this way, still remains. While the trick of combining pictures by either of these two methods is quite worth learning for its own sake, this objection may nevertheless be true for some few persons who are lacking in visual control or who may be discouraged by an initial failure. For them, however, there still remain the two photographs composing the stereoscopic pair, and although they would miss a full comprehension of the subject they would gather a good deal from the examination of either of these pictures taken singly : and if it is thought necessary to cater further for the incapable, it can still be done by providing an instrument which is neither cumbrous nor expensive.

This instrument is no more than a small mirror, of silvered glass or nickel-plated metal, which can be slipped into a flap pocket in the cover of a book. For use with thin paper-covered publications one might rely on the reader possessing a small mirror of his own. The diagram (Fig. 4) explains the method, and there is no difficulty connected with its use. It will be seen, however, that one of the photographs has to be printed with the film side of the negative uppermost, or otherwise arranged so that it faces the opposite way to its fellow, in order that the two mirror-images may coincide (Fig. 3 of Plate XII).

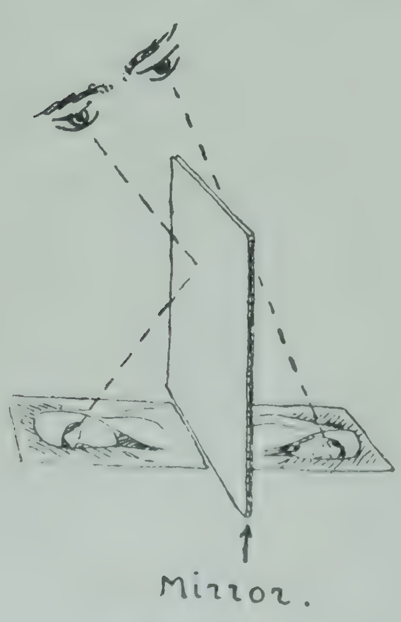

Fig. 4.

There are thus three methods which seem most suitable for the ordinary purposes of illustrating :—

(1) Directing the eyes to a point behind or through the photographs. The photographs must not be more

than $2\frac{1}{4}$ inches wide, and are placed close up to one another. They can be 4-6 inches high if desired, and can be viewed through ordinary Brewster prisms.

(2) Directing the eyes to a point in front of the photographs, which must be printed with the right-hand one on the left and *vice versâ*, and so cannot be viewed through an ordinary instrument. They can, however, be of any reasonable size, up to at least six or eight inches square.

(3) Using a mirror. The photographs must be printed facing opposite ways, but their size is limited only by that of the mirror which is to be used for combining them.

As regards the cost of reproduction and printing, if the photographs are quite small, as they very often could and would be, the fact that there are two of them need not double the expense, since all firms have a minimum charge for block-making corresponding to a size of block which will often be larger than one member of the stereoscopic pair. Using any method, it would frequently be quite possible to keep the area of the whole double block within the ordinary minimum of nine or ten square inches.

In the actual reproduction of any stereoscopic prints, *it is essential,* particularly in India, to dispense as far as possible with all touching up : and although excellent results may be obtained by the use of the ordinary half-tone process, collotypes are really preferable for this reason.

The ordinary stereoscopic camera can be used for taking some subjects. For others which are required to be taken at close range, an ordinary long-extension camera can be employed, taking two photographs one after the other from two different positions, the camera being shifted a certain distance to the right or left after the first exposure has been made. In deciding how far the camera should be shifted, it seems sufficient in dealing with distances up to a yard or so to keep to the very rough rule that the shift should be three inches for every foot distance of the object up

to six feet. For an object five feet away the shift would then be fifteen inches.

The advantages of stereoscopic illustration of dissections, anatomical structures or general morphology of animals or plants, complex machines or apparatus, curve-systems, and indeed of anything which requires an understanding of its extension in all three dimensions, need not be elaborated. It may be as well to point out, however, one direction in which explanations of form can be simplified by its use : this lies in the increased employment of models, stereoscopically photographed, in the place of diagrams in which only variation in two dimensions can be properly or adequately shown. The model can often be made as easily or even more easily than the necessary drawing, and gives a much more satisfactory idea of any point connected with three-dimensional form. The use of surfaces to illustrate the relations of three variants, such as the pressure, volume, and temperature of a gas, is already familiar, and for such cases, as well as for those of the kinds already briefly indicated, the possibilities of stereoscopic illustration seem worthy of more than passing attention.

THE DEVELOPMENT OF AGRICULTURAL CREDIT IN INDIA.

BY

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THE redemption of debts among the agricultural classes was one of the problems discussed at the last Provincial Co-operative Conference held in Poona. The Select Committee that went into the matter considered that direct financial aid from Government need not be re-introduced for the purpose of assisting Co-operative Credit Societies in the redemption of old debts. It was of the opinion that immediate redemption of old debts on a large scale is impracticable and that so far as redemption through Co-operative Societies is concerned, progress must be in accordance with the natural development of the Societies. It, however, acknowledged that information was desirable and recommended that the operations of the various Societies towards the redemption of old debts should be carefully watched and the results regularly published.

It must be admitted that this indebtedness is a result of various causes such as improvidence, initial poverty, illiteracy, uneconomic customs, uneconomic small holdings, etc. The problem has, therefore, to be attacked from several sides. The fact is that this standing indebtedness absorbs in the shape of interest every year a considerable share of the cultivators' income with the result that in many cases the major portion of their profits disappears and they fall more and more into the hands of *sowcars* from whom they borrowed at first. It is true that Takavi Acts, Agriculturists' Loans Acts and Agriculturists' Relief Acts have afforded the cultivators valuable help. It is also true that with the general rise in prices

of agricultural produce and the opening up of communications, the economic position of the cultivator has comparatively improved. There is, however, a large amount of indebtedness among the rural population. If a practical working scheme could be devised for extricating the *raiyats* from the *sowcar's* clutches and arrangements made for financing them at reasonable rates of interest so as to enable them to carry out permanent improvements on their land, the work of agricultural improvement in this country would be greatly facilitated. For, it must be remembered that, under modern conditions the possession of a reasonable amount of working capital is an essential as the "higher" the farming is, the higher the initial expenditure must be. This outlay is, however, ultimately amply repaid by the increased profits. It is therefore obvious that until cultivators are prepared to lay out more money to that end there can be no rapid improvement in the agriculture of this country. As the Director of Agriculture, United Provinces, remarks in his last Annual Report "the Department cannot work miracles nor raise to affluence holders of minute areas who have neither cattle to work the land properly nor sound seed to sow. Inevitably the Department tends more and more to work for and with the cultivating zamindar, larger tenant or members of societies who can command the small amount of capital required to carry out its recommendations. The cost of production, particularly the price of cattle and labour, is increasing ; all the present tendencies are towards the elimination of the small and impoverished tenant, and from the point of view of agricultural progress there is nothing to be gained by trying to bolster him up. This is an economic change which will only slowly make itself felt. Meanwhile it is well to recognize that agriculture, like all other businesses, requires some capital ; and to improve and develop the business more capital has to be introduced. The Department would be retarding rather than assisting development if it measured its activities by the capacity of weaker and less progressive section of the agricultural community."

The agriculturist requires two kinds of credit which may be called long-term or land-mortgage credit and the short-term or

personal credit. The money raised on long-term credit must be in the shape of a more or less permanent investment or in the shape of a loan extending over such a long period that it can only be gradually reduced and paid off out of the increased profit derived therefrom. The short-term credit is only for the temporary or annually recurring requirements of the farmer such as the money required for purchase of seeds and for performing agricultural operations before the crop is sold and is similar to the credit required by a merchant or manufacturer who can usually dispose of the stock he has bought and repay the loan in about 3 months.

The main difficulty with regard to the financing of farming as compared with other industries lies in the nature of the business. The better the farmer, the more capital he should have locked up in his land, fixtures or stock, as these are obviously the avenues by which his capital earns its maximum interest. The operations necessary in connection with a single crop are prolonged and the turn over of necessity slow. The returns are also liable to be irregular and uncertain since they depend not only on ordinary skill, but also on a thing which can be rarely said to enter into the consideration of any large financial firm—*i.e.*, that most changeable and uncertain factor,—the weather. These considerations and the difficulties inevitably associated with the recovery of small sums in case of default from individual cultivators, make the average bank naturally reluctant to lend money to farmers at a moderate rate. The case becomes worse as the need becomes greater for in a region of scanty, or worst of all precarious, rainfall the risk is almost inhibitive except to a philanthropic institution.

In Egypt where the supply of irrigation water is assured, the problem of financing the Egyptian cultivator has been solved to a considerable extent by means of the Agricultural Bank of Egypt which is an ordinary business institution run on commercial lines but with a backing from Government. This Bank has for practical purposes the right of summary recovery in cases of default.

On the Continent Land Banks have been started to provide for land-mortgage credit. These Banks enable land-owners, and especially those who own comparatively small areas of land, to

obtain money on mortgage at a low rate of interest and also free them from the risk of the outstanding amount of the mortgage-debt being suddenly foreclosed. An Official Commission was appointed by the Congress of the United States of America some two years ago to study on the spot co-operative institutions in Europe and to ascertain how far the lessons to be learned from the working of co-operation in Europe could be applied to American conditions. The report bears witness to the remarkable results obtained on the Continent chiefly owing to the growth of agricultural credit and discusses the characteristics of the land-mortgage institutions existing in the different countries of Europe. The findings and recommendations of the Commission are briefly summarized in the *Bulletin of Economic and Social Intelligence*, Rome, May, 1914, and also in the *Journal of the Board of Agriculture*, London, October, 1914. The Commission has submitted for the consideration of Congress a Bill to provide for the establishment of a National Farm-land Bank System, the main principles of which we give below. It is true that conditions in this country differ vastly from those on the Continent and America, but it is possible that we may be able to apply these principles with suitable modifications to Indian conditions. Co-operative Societies in India lend money to their members to enable them not only to meet current agricultural expenses but also to pay off old debts and to make permanent improvements to land. They are providing valuable help to their members in the matter of short-term credit, but in many cases the funds of these societies are not sufficient for the long-term loans required for the improvement of farms or estates or for the purchase of new ones by those who can make best use of them. It is true that they are financed by Central Co-operative Societies, and in Bombay the Central Co-operative Society is giving annually increasing sums to the smaller societies for debt redemption, but these will not be able to tackle the whole problem. An examination of the principles governing the Land Bank system which has worked so successfully elsewhere will not therefore be without interest and may possibly indicate a line of advance suitable to the conditions of this country.

The Bank recommended for the United States is either a type of the Joint Stock Bank or a Co-operative Bank in which an individual stock-holder should not be allowed to own more than 10 per cent. of the share capital, each member to have one vote irrespective of the number of shares held by him, profits to be distributed on the co-operative principle, each stock-holder receiving a return on his investment equal to the general prevailing rate of interest in the community while the remainder of the net earnings is distributed among the borrowers in proportion to their borrowings.

The Bank will grant loans to land-owners only on agricultural land. The amount of the loan given should not exceed 50 per cent. of the value of improved farm-lands or 40 per cent. of unimproved lands, the value being determined by an appraisal.

The maximum duration of a loan should be 35 years and all loans must be secured by first mortgages. The only legitimate objects for which the loans can be given are specified as (1) completing the purchase of the lands mortgaged, (2) improving and equipping such lands for agricultural purposes, (3) discharging debts secured by previous mortgages on those lands. Loans made for more than 5 years must contain a provision for the gradual reduction of the loan by yearly or half-yearly payments on account of principal. Every such loan may be paid off in whole or in instalments by the borrower any time after the loan has continued for 5 years. The instalments for repayment of the principal are to be regulated by amortization tables approved by the Government and each such payment should be recorded on the mortgage-deed.

The Bank should have power to issue Bonds, guaranteed by the deposits of first mortgages of equal nominal value maturing not less than 5 years from date. All such Bonds shall be payable on a date specified and redeemable at par at any interest-period after the date of issue, due notice being given.

The mortgage-deeds held as security for Bonds shall be in the joint possession of the Bank and of the special Government official appointed to supervise the working of the Bank. No Bond shall be issued against any mortgage running for less than five years.

The amortization payments as made must be credited upon the mortgage-deeds deposited as security and the Bonds issued by the Bank must be called in and paid or purchased in the open market and cancelled, to the extent of the amounts thus credited so that the total face value of the Bonds outstanding will always be approximately equal to the value of the loans still secured by the first mortgages held by the Bank. The amount of the Bonds outstanding must never exceed 15 times the capital and accumulated surplus of the Bank. The rate of interest charged by the Bank for such loans should not exceed the interest paid on Bonds issued by the Bank by more than 1 per cent. per annum. This 1 per cent. will be sufficient to cover the working expenses of the Bank. The Bonds should be for sale in the open market and, as they will be fully secured by the first mortgages of farm-land held by the Bank, it is expected that they will be regarded as "Gilt-edged securities" and will command a full and steady price on the lines of trustee stock. The ultimate security for these land-mortgage Bonds will be the contract-payments to be made by the borrower to the Bank and the sale of the land in case of default of such payment. In European countries such default is of very rare occurrence and the sale of mortgaged property very exceptional, but for a Land Bank of this type to succeed, it is necessary to have a system providing that the registration of title, the transfer of land and the foreclosure on mortgages shall be carried out as simply, as cheaply and as promptly as possible with regard to law costs.

These Bonds should be made a legal investment for all classes of savings and for insurance reserves. This will have the salutary effect of making the savings and deposits accumulating in urban centres, available for the development of rural communities. The Bonds should also be made a legal investment for Trust Funds and Court of Wards estates and a legal security for loans from other Banking Associations either to these Land Banks or to individuals. This is suggested with a view to raising the status of such Bonds by making them easily negotiable on a wide market. They should in fact be looked upon as secure as Municipal, or Port Trust Bonds in India or in fact any Bonds secured on the Rates.

In order to furnish the Banks with the fluid working capital they should be permitted to accept deposits up to 50 per cent. of their capital and reserves and to do ordinary banking business within the limits set by the amount of such deposits. The Banks would also be free to invest not more than 50 per cent. of their working capital in mortgage loans for periods not exceeding 5 years, against which however no Bonds can be issued. Further, each Bank would have power to buy and sell its own Bonds as well as those of any other Land Bank subject, however, to the condition that at any time not more than 50 per cent. of its capital and surplus was invested in such Bonds or in short-term mortgages. This provision is an essential as it enables the Bank to maintain a steady market for its Bonds and at the same time earn a legitimate profit by timely dealing in them.

The amount of deposits which could be accepted by the Bank is limited to 50 per cent. of its capital and accumulated reserve on the grounds that these Banks are not intended to compete with commercial Banks and the holding of deposits for which there may be a sudden demand is likely to endanger the safety of an institution which is chiefly engaged in making loans for long periods.

It will be open to the Bank to invest the balance of its capital and surplus in interest-bearing securities approved by the chief Government officer controlling such banks.

Not only the capital of the Bank but also the mortgages held by the Bank and all the Land Bank Bonds issued against such mortgages should be exempted from taxation as any tax in such cases has ultimately to be paid by the farmer himself in the shape of increased interest charges, which defeats the very object in view of providing cheap capital.

It is necessary that the State should supervise through its officials and see that the regulations are properly carried out and certify every Bond issued as being fully secured.

The Commissioners point out that the security of the lands with the yearly payments is ample for the creation of a liquid security which will be readily accepted by investors. In this way the farmer

will be enabled to use his asset of land as readily as a merchant uses his stock of goods.

It will thus be seen that the Bank described above would lend money only to owners of land and then only for the purpose of completing the purchase of the land, improving and equipping it for agricultural purposes or liquidating a previous mortgage held at a higher rate. The advantage to the land-owner would be that he would, in return for the mortgage of his land, obtain a loan from the Bank at a comparatively low rate of interest under an agreement which would enable him to pay off the amount by small instalments ; and so long as he did not default in the repayment of an instalment, the Bank would have no power to call up the balance of the loan or to foreclose the mortgage. On the other hand, the land-owner would be free to pay off the balance of the loan and release his land from mortgage at any time that suited him after the first 5 years.

The advantage of having such institutions in those parts where local conditions seem suitable is therefore obvious in India. The provision of funds by such a Land Bank will very greatly aid the cultivators in the *zamindari* and *ryotwari* tracts. It will also lead to an increase in outturn as the rate of agricultural production in case of intensive farming must be in proportion to the amount of capital sunk in permanent improvements, given an equal skill in farming on the part of all occupants. It will also enable the actual cultivators in some provinces to purchase outright the land which is at present held by non-agricultural communities who sublet it on short-term leases. The result will then be better farming.

Let us examine what modifications or local adjustments would seem to be required to make these Land Banks suitable for India.

In the present stage of development of the co-operative movement in India, the proposed Bank might be a profit-making institution somewhat similar to the ordinary Joint Stock Bank.

The valuation of agricultural land is not an easy matter. In order that the farmer may not suffer from under-valuation and also to

safeguard the interests of the Bank in the successful working of which the State is equally interested it would seem necessary in this country that the valuation arrived at by the Directors of the Bank should be approved by the Revenue authorities of the district in which the land is situated. This would no doubt add considerably to the amount of work already being done by the Revenue Department.

The Registrar of Co-operative Societies or the Registrar of Joint Stock Companies would be a suitable official to watch over the working of these Banks.

In view of what we have already seen as regards the working of native Banks, it is essential in India that the conditions regarding the strict observance of regulations and the certifying of every Bond issued as being fully secured should be most rigidly enforced in order to avoid possible failure which would counteract against the confidence of the whole country in the scheme.

The crux of the situation comes in when we consider the question of recovery of outstandings in cases of default. It obviously would not pay a Land Bank to go to the Civil Court in every case of default often very small, and therefore a grant of special facilities for recovery would seem to be required.

These are only a few of the points considered in general, but on detailed examination it will appear to the interested enquirer that many more local adjustments and modifications are required before a scheme of this kind could be made suitable to the various parts of this country. But in view of the great necessity, which is undoubtedly to the general interest of the community, of helping the cultivator to obtain sufficient cheap capital to maintain or increase the fertility of his land, and at the same time realizing the cold fact that agriculture—*the national industry of this country* is almost entirely devoid of any organization and keeping in mind the remarkable results obtained from such Land Banks in Europe, it must be obvious that a careful consideration of the most suitable type of Land Bank for this country is called for urgently.

A ROT OF BANANAS.

BY

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Since May 1914, a disease of bananas, resembling in some external symptoms the Panama disease, has been under observation at Pusa. The variety that has been found to be the most attacked is the *Kabuli* or *Bengali; Kanthali, Chini Champa*, and *Martban* are however not immune.

The diseased plants, from a distance, look as if they were suffering from drought or bad cultivation. The lower leaves begin to turn yellow, generally from the margin inwards and ultimately become brown and shrivelled up, but the blades do not necessarily break down at the base of the stalk, and gradually this process moves up the trunk involving at times all the leaves. These symptoms are not always found whenever the disease is present, at least in its early stages; sometimes the blade remains green long after the leaf sheath is attacked, and at times it turns brown without first turning yellow. The leaf sheaths lose their healthy colour, become soft and watery and the trunk splits lengthwise. In some cases the diseased leaf sheaths get separated from the trunk, especially at the base of the crown; in these cases the stalk of the leaf blade frequently breaks down (Plate XIII, fig. 1). The outermost leaf sheaths of a healthy trunk are generally without leaf blades, the blades having been either removed or having withered away; the dried tops of these leaf sheaths seem to be a suitable breeding ground for this disease as the infection has often been

PLATE XIII.

Fig. 1.

Fig. 2.

A ROT OF BANANAS.

first found at these places, the rot of the leaf sheath commencing from the top downwards. The inner leaf sheaths may become infected from the outer leaf sheaths. The newly diseased inner leaf sheaths show the point of infection by the presence of discoloured red or brown spots, which have a dark centre surrounded by a diffused lighter area. As these spots grow, the rotting of the leaf sheaths begins and consequently the leaf blades turn first yellow, then brown and ultimately wither. That the inner leaf sheath may be directly infected by the diseased outer leaf sheath is probable from the presence of fructifying hyphæ on the inside epidermis of the outer sheath. These hyphæ bear *Cephalosporium* spores ; in cultures they give *Fusarium* spores as well and this latter kind of spores is also at times found on the leaf sheath. Cultures from pieces of diseased parts, sterilized by flaming after soaking in rectified spirit, have given a *Fusarium* with a *Cephalosporium* stage. Sections from diseased areas have shown the fungus not only in the wood cells, as found by Ashby[1] and Drost[2] in case of the Panama disease, but also in the cortex and *Cephalosporium* spores borne on short conidia have been observed in some cells. The walls of the cells of the infected tissues usually take on a brown yellow, honey or vine coloured discolouration and the lumen of the cell is sometimes filled with an insoluble gum of the same colour.

As a rule the trunk is first attacked, the disease proceeds inwards and may ultimately kill the plant but cases have been found in which the attack commences from the heart leaf. If the attack is not severe the growth of the plant is not checked. When, however, the heart leaf comes out from the centre of the crown some portion of its still folded leaf blade is found to be damaged. The diseased portions are brown or black in colour, they are unable to unfold themselves along with the healthy parts of the leaf blade, and consequently get torn to pieces (Plate XIII, fig. 2). The area

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[1] Ashby, S. F. Banana Diseases in Jamaica. *Bull. Dept., Agri., Jamaica*, N. S. II, No. 6, 1913.

[2] Drost, A. W. The Surinam Panama Disease of the Gros Michel Banana. *Bull. Dept. Agri., Jamaica*, N. S. II, No. 6, 1913.

surrounding the diseased parts is chlorotic and almost white. The leaf bud enclosed by the heart leaf may completely escape infection. In other cases the attacked heart leaf is at times observed to come out of the green and healthy crown but it is twisted, crumpled and brown and its growth is completely checked; white and pink ascervuli are found on it. These are the beds of *Cephalosporium* and *Fusarium* spores. The leaf buds enclosed within this heart leaf may also be attacked and their growth checked; but, under favourable circumstances, the disease does not make headway and the growing point continues to grow and after a long time a new healthy leaf is observed arising from the crown.

In some cases the growth of the plant is completely checked. Except for the absence of the central unopened leaf there is nothing unusual about the appearance of the plant, the crown leaves are green and healthy and so is the trunk. When such a plant is split open, it is found to be rotten at the core with the heart leaf a black, putrid, crumpled mass. The surrounding sheaths are also attacked. The rotting has invariably been found to commence from the apex downwards, the infected portion being black and rotten. The soft tissues are destroyed leaving behind shreds of fibres; in advanced cases the rotting tissues give out a characteristic foul smell. From such an attack the plant, of itself, has not been found to recover; but if the trunk be cut as far back as the healthy part the growing point puts forth new leaves. Of course the vitality of the plant is very poor and consequently it produces very poor fruits.

In the Panama disease which has been found by Drost[1] and Ashby[2] to be due to a *Fusarium* with a *Cephalosporium* stage, and in the Chinsurah disease reported by Basu[3] to be due to the same genus, the attack in all cases is sudden and rapid, so

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[1] Drost, A. W. The Surinam Panama Disease of the Gros Michel Banana. *Bull. Dept., Agri., Jamaica*, N. S. II, No. 6, 1913.

[2] Ashby, S. F. Banana Diseases in Jamaica. *Bull. Dept., Agri., Jamaica*, N. S. II, No. 6, 1913.

[3] Basu, S. K. Report on the Banana Disease in Chinsurah. *Quat. Journ. Dept., Agri., Bengal*, IV, No. 4, 1911.

PLATE XIV.

Fig. 1.

Fig 2.

that once the field is diseased it is soon completely destroyed. This is not the case with the disease at Pusa. The progress of the disease is slow and it does not always prove fatal. When a leaf is attacked the disease has been found to remain confined to some portion of the leaf and not to envelop the whole leaf; in cases where the trunk is attacked, the disease may spread on to the whole trunk and ultimately may kill the plant but death occurs long after the infection has first been observed. Sometimes the disease is found to have ceased growing after having attacked almost the whole of the trunk. In this case the outer leaf sheaths are dry and leathery, their softer tissues being almost destroyed and the fibrous tissues in shreds. The outer leaves are completely brown and leathery to touch. That the plant is not killed is evident from the presence of one or two central new green leaves or from the presence of a fruiting bunch, if the plant be bearing. These fruits ripen normally but they are smaller in size and fewer in number. This condition is more particularly applicable to the *Bengali* or *Kabuli* variety. When the top of the trunk is attacked and the crown of leaves is destroyed the heart leaf in some cases instead of coming out from the centre of the crown breaks through the healthy part of the split trunk and comes out from its side. The diseased parts of the plant wither and drop off; it continues to grow but remains a weakling and bears a fruit bunch with very few fingers. Not only has the heart leaf been found to emerge from the side of the trunk but the flowering stalk as well (Plate XIV, fig. 1). The progress of the disease can be checked if the infected leaf sheath or leaf be removed in the early stage of attack.

This disease does most damage when the stalk of the fruit bunch is infected, and it is remarkable that the attack is generally found on the upper surface of the stalk (Plate XIV, fig. 2). If the stalk gets diseased in the early stage of its development the whole bunch is destroyed before the fruits ripen; but they ripen normally if the attack is late. The diseased part is black, surrounded by a diffused purplish area. As this attack progresses the diseased part becomes soft and sunken, the cellulose tissues being destroyed, leaving behind strands of fibrous tissues. From the stalk the disease

proceeds to the fingers. If the stalk gets attacked from within the trunk, it breaks at this point on account of the weight of the fruits even though the attack be not severe. Only in one or two cases has the attack been found to proceed from the tip of the finger inwards. The diseased tips are black and wrinkled and show a pinched-in appearance. Hyphæ bearing *Cephalosporium* spores have been found inside of these tips ; in cultures they have produced the *Fusarium* stage.

Two important and characteristic symptoms of the Panama disease and of the disease at Chinsurah, which appears to be identical with the former, have not been found in the disease at Pusa. There is a sudden appearance of imperfectly developed leaves in the former. Such leaves have not been found till now on the affected plants at Pusa. Again at all stages of the growth, if a head of a "sick" tree be cut it will be found to be diseased. In nature the head or the "yam" has not been found to be attacked at Pusa except in rare cases when the whole of the leaf sheath is completely rotten and the disease then travels from the base of the leaf sheath to the head. Here the disease has always been found to travel from the top downwards and not from the yam upwards. Whether this disease is present in many other places is not known but it was found during a short visit to Muradabad last year.

Inoculation experiments with pure cultures taken from diseased parts have given positive results. Suckers of *Kabuli* or *Bengali* variety were inoculated with pure cultures of the fungus. The outer sheath was inoculated through a wound made by a sterilized knife. The outer leaf sheath of another sucker was inoculated at the point where the blade had withered and fallen off. The effects of the inoculation were seen within a week. The inoculated leaf sheath began to rot ; the rot spread downwards and inwards and the heart leaf broke through the side of the trunk (Plate XV, fig. 1). From the rotting part *Fusarium* hyphæ and spores were found. In another case the tip of the heart leaf enclosed within the sheathing petiole of the newly opened leaf was nipped and then inoculated. When the heart leaf grew out of the protecting petiole it was only partly able to unfold itself. The portion where

PLATE XV.

Fig. 1

the inoculation had taken effect was black and shrivelled up, and remained unopened (Plate XV, fig. 2).

Inoculations by injecting with a hypodermal syringe *Fusarium* spores suspended in distilled water have been successful; in one case the heart leaf was hidden in the centre of the trunk when the injection was made, so it was got at by introducing the needle through the base of the outer leaf stalks. When the heart leaf opened, the midrib and some parts of the blade were found to be injected. That the inoculation on the midrib was successful was evident from the presence of purplish longitudinal streaks originating from the injected portion. This discolouration extended to the whole circumference of the midrib for a couple of inches below and above the place of inoculation. About a fortnight after the inoculation the midrib was cut through this discoloured portion and the tissues were found to be rotting. Microscopic examination showed the presence of *Fusarium* hyphæ and discoloured cells filled with some insoluble gum, as in the case of naturally infected tissues. The margins of the puncture made by the needle on the blade were brown, and surrounded by a chlorotic area when the leaf had just opened. Sections made from these portions showed the presence of *Fusarium* hyphæ and purplish or brown coloured gum in cells.

The underground stem has also been successfully inoculated. A small piece was removed from the head underground; mycelium from a pure culture was introduced in the cavity and the piece replaced in position. After a month the inoculated plants were dug out and the infection was found in all stages of progress. The badly infected area was a brown putrid mass; the newly infected tissues at a distance from the seat of infection were firmer and vine red in colour. In cases where the infection had not advanced much the tissues near the point of inoculation were brown but firm, and the presence of the infection beyond this browning was noticeable in a section across the bulb as black or brown dots corresponding to the position of the vascular strands; in a longitudinal section these dots are seen as streaks criss-crossing one another. Unlike the Panama disease, the hyphæ have not been found confined to the vascular tissues.

From the preliminary study of the pure cultures obtained from the diseased parts it seems that this *Fusarium* with a *Cephalosporium* stage differs from that studied by Ashby in pure cultures as the cause of the Panama disease.

EXPLANATION OF PLATES.

PLATE XIII, Fig. 1 .. A badly diseased plant on the right. The leaf sheaths have got separated at the base of the crown and the stalks have broken down.

The plant on the left shows the infection commencing from the dried top of the outer leaf sheath.

„ Fig. 2 .. A diseased newly opened leaf. The badly attacked portions of the blade are torn; the chlorotic effect is to be seen on the lower right-hand portion of the blade; the left part of the blade has remained unopened.

PLATE XIV, Fig. 1 .. A diseased plant with the fruit bunch coming out through the split trunk.

The plant on the left shows similar conditions as noted in Fig. 1.

„ Fig. 2 .. A diseased fruit stalk; the white areas are the spore beds.

PLATE XV, Figs. 1 & 2 .. Inoculated suckers.

In Fig. 1 the sucker was inoculated through a wound made on the top of the outer leaf sheath. The infection is seen travelling from the top downwards. The trunk has got split and the heart leaf has come out from the side of the split trunk. The growth of the leaf at the top of the trunk was checked after the inoculation took effect. The plant was inoculated on 26-5-14 and photographed on 14-6-14.

In Fig. 2 the top of the heart leaf enclosed within the sheathing petiole of the central leaf was nipped and then inoculated. When the inoculation had taken the leaf was black and remained folded. The infection has travelled to the sheathing petiole as well. The plant was inoculated on 26-5-14 and photographed on 12-6-14.

PLATE XVI.

8 H. P. Low Pressure Steam Engine and Ransomes' Thresher at Lyallpur.

TRIAL OF STEAM THRESHERS AT LYALLPUR.

BY

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Two of Ransomes' Threshers were worked in Lyallpur in May and June. 1914, *viz.*, a 30-inch feed type, which also worked in 1912 and 1913 and a 48-inch feed type obtained just before the 1914 harvest. A note giving some of the main points in the construction of these threshers, by Mr. Armes, the Agent at Lyallpur of Messrs. Ransomes Sims and Jefferies and of Messrs. Octavius Steel & Co., Calcutta, is given below :—

Notes on the N. I. L. type Thresher.

This thresher differs from the usual type so commonly used at home insomuch that no threshing drum, as it is commonly called, is used. In the ordinary type the threshing is performed in a large diameter drum after the grain has been separated from the straw. In this machine the wheat is threshed and partly bruised in the first or feeding cylinder and the grain is taken out by passing down sieves before the straw is finally bruised.

Both drums are simple cylinders fitted with beaters which are set helically on the drum and made to revolve through a concave fitted with abutments. The degree of fineness of the *bhusa* is governed principally by setting the concave nearer or further from the cylinder.

In this type of machine the straw must be fed across the machine and not lengthwise as in the ordinary machine. It is because of this that the output of the machine with a wider feed goes up out of all proportion with the width of the machine. When the straw reaches the second cylinder, all grain has been extracted, and so the drum and concave can be set very close to reduce the straw to a very fine state.

The straw and chaff may be mixed or kept separated at will. The wheat is elevated to the second dresser by means of a powerful fan and not by belt and buckets as usual.

This fan also acts as an awner and cleans the chaffs and unthrashed heads. The grain passes through the second dresser but is not screened as it appears quite unnecessary in this country.

The machine is supplied with all tools, sieves, etc., required for wheat, barley, etc.

This machine is fitted with a special ball lock to the front wheels which relieves all undue strains on the frame of the machine when travelling over uneven country. It can be fitted for being drawn by bullocks or by tractor.

The power required is very small and a 30″ machine can be driven by a 3 N. H. P. portable engine.

The grain can be separated into two qualities or all delivered unsorted into the bags.

The 30″ size previously worked had proved unsuitable on account of the low yield of grain per hour. In the Colony, wheat has generally long and coarse straw, with the result that the proportion of *bhusa* to grain is generally a good deal higher than in the more settled districts or in *barani* (rain) tracts. A crop giving an outturn of 20 mds. of grain here, often gives 55 to 65 mds. of *bhusa* and sometimes as much as 90 to 100 mds. In the last harvest owing to a hail-storm on March 2nd the proportion of straw was still higher, thus making the outturn of the threshers appear lower than in a normal year.

The 30″ *Thresher.*

This machine was worked near Buchiana to the east of the District, and visited about 10 places, working for 2 or 3 days in each place. The arrangements for the work of this machine were made by Rai Sahib Sewak Ram of Gangapur. Users were charged half rates only, *i.e.*, 2 annas a maund ; coal and oil being supplied by Messrs. Octavius Steel & Co. The outturn of grain per hour works out @ 4·62 mds., the total number of working hours being 160.

The 48″ *Thresher.*

This machine was worked on the same lines as above near the Agricultural Station, and visited 8 centres within 10 miles of the Farm. A traction engine was used in the earlier stages of the trial to drive the machine. This latter ran very unsteadily and caused some belt trouble. Later on an 8 H. P. low pressure steam

PLATE XVII.

engine was obtained and the work progressed much more smoothly than previously. The average outturn was 10·48 mds. per hour with a total of 180 working hours. The highest average for one day was 12·74 mds. per hour on the 3rd May, the machine working for $8\frac{1}{2}$ hours.

The quality of the *bhusa* was extremely good, but in some places from 2 to 5 per cent. of the grain was damaged or cut. Mr. Armes was of opinion that this was due to the grain being brittle—it only occurred appreciably in two of the places worked at, where the wheat was a mixed awnless type.

Difficulty was experienced in moving the thresher and engine from place to place with ordinary village bullocks. Two or three pairs of fair sized and well trained bullocks, however, moved either the thresher or the engine easily, over ordinary roads.

Another difficulty has been in securing good feeders ; the output as may be expected depending largely on the feeding. A number of men, however, have been trained now. Dust caused a good deal of trouble to the feeders, being very much worse than under home conditions. Protectors specially designed for this work have recently been obtained for use. These trials have shown the marked superiority of the 48″ machine and they are being continued when the cost of working, etc., will be worked out in detail.

THE IMPROVEMENT OF NATURAL GRASSLAND IN INDIA.

BY

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In India the question of fodder for cattle is perennial. On an abundant fodder supply depend the number and strength of work animals, and on them depend the efficiency of farm operations and, to a large extent, the supplies of fuel and manure. Milk production is also intimately connected with the fodder problem. The attention given to this problem by the Imperial and Local Governments, and by the Forest and Agricultural Departments is proof that its importance is recognized. Admirable work on the indigenous wild fodder grasses has been done by Mr. R. S. Hole, the Imperial Forest Botanist, and many useful suggestions have been made by him for the improvement of grassland.[1] The subject, however, is many-sided, and is worthy of all the consideration and discussion that can be bestowed on it. The present paper deals with a few salient points.

We may roughly divide fodders into two classes, namely, those grown for the purpose of feeding to stock, and those naturally occurring on uncultivated land. In the Bombay Presidency the most widely cultivated fodder plant is *jowar* (*Andropogon Sorghum*

[1] On "Some Indian Forest Grasses and their Ecology," by R. S. Hole. *Indian Forest Memoirs, Forest Botany Series*, Vol. 1, part 1, 1911.

"Selection of papers relating to the measures taken in the various provinces for the utilization of fodder and forest grasses from reserved, protected, and unclassed Government Forest," published by the Government of India, Department of Revenue and Agriculture, Simla, 1914. This contains a valuable note by Mr. Hole.

Brot.) Wherever a cultivated fodder crop can be grown in the Presidency there is no doubt that this plant meets all requirements. It would be foolish to attempt to replace it by wild grasses of less bulk and greater uncertainty of yield.

The improvement of fodder growing on uncultivated areas is entirely another matter. Such areas are (1) reserved and other forests, (2) waste or uncultivated lands, (3) headlands and uncultivated ground between fields, and (4) village grazing grounds. The vegetation borne by such areas is of a very mixed and varied character, changing according to the soil and climate of the place. The following are one or two typical cases investigated by the present writer.

A square metre in a fruit plantation of medium black soil in the Nasik district showed in August thirteen species of which five were grasses, and two belonged to the natural order of the *Leguminosæ* which might be called, in English terminology, "clovers." The other species were plants of little fodder value. The whole vegetation of this plot was regularly cut for fodder.

Wild grassland at Tegur, in the Dharwar district, showed in October fifty-nine species of herbaceous plants, about a third of these being grasses and *Leguminosæ* of known fodder value. The rest of the vegetation was of a very mixed nature and contained a considerable amount of the parasite *Striga euphrasioides.*

On deep alluvial soil in the Thana district, in a famous grass area, practically nothing but true grasses grew in the month of October, all of them being of value as fodder.

On the bund between two ricefields in the same district, in November, there occurred a very different group of plants, containing twelve species, of which only four were grasses and three *Leguminosæ.*

These few examples give an idea of the areas with which we are concerned, and the question before us is: "Can the vegetation of these areas be altered and improved by artificial means?" There is no *à priori* argument against the possibility of such an improvement, and the practical application of the science of ecology, which deals with the relation of plants and plant communities to their surroundings, should assist us in the attempt. Indications of the

kind of improvement possible have been given by Mr. Hole,[1] and another possible line will be here indicated. The obvious line of attack is to increase the number and possibly the species of the useful wild fodder plants inhabiting such places by sowing their seed. There is no objection to the trial of exotic plants, but there is little likelihood of their succeeding in competition with the indigenous wild vegetation. The present writer is not concerned with the areas under forest control, and these remarks refer only to areas outside forest, which are often large and important. For the purpose of this article grazing grounds and grasslands which yield hay only will be considered together.

The first step in an improvement of the above-mentioned type is a chemical and botanical investigation of indigenous wild fodder plants, in order to determine (1) their feeding value as far as chemical analysis can show it, and (2) their life history and growth. In addition, agricultural experiments are necessary for the determination of yield, and the actual effect of such plants on the cattle that eat them. Investigations of this type have been carried on during the past three years by Messrs. R. K. Bhide, L. B. Kulkarni, and S. N. Hanamante of the Bombay Agricultural Department. To illustrate the kind of information collected, the following facts concerning one useful species may be quoted.

Andropogon annulatus, Forsk. *Marvel*, also *Jinja* (Panch Mahals) *Sheda, sam, payen, palwan.*

This is one of the best known and most appreciated of the wild fodder grasses of the Bombay Presidency. It thrives best in heavy rainfall tracts and requires a well drained situation. On high plateaux and hills where the soil moisture supply is low, its place is taken by *Anthistiria* and other types of grass. Where moisture in the soil is in excess, the *Cyperaceæ* (sedges) replace it. It is not distinctly a deep-rooted plant or a surface feeder. It spreads along the ground to some extent, sending out roots at the nodes. Although this grass is fairly common, extensive areas of it are rarely seen. It is usually either grazed or fed green. It is

[1] *Loc. cit.*

highly relished by cattle, who will sort it out of a mixture and eat it first. As a green succulent fodder it always gives good results in milk production, and no undesirable odour is developed in the milk. It makes a hay of good quality and as the stem is solid, can be turned into silage. For hay-making it is always advisable to cut it when in flower, otherwise the stem gets rather thick, and the hay obtained is coarse. Wastage also occurs in feeding, and especially so in the unchaffed condition.

The plant is perennial, as proved by the fact that seeds sown in the Ganeshkhind Botanical Garden in 1911 produced plants that in 1915 were still giving cuttings from the original stumps. In this experiment the plant was found to keep green till December, and then to turn brown. In April and May it is completely brown and dry, but puts out fresh green shoots at the break of the rains. In good conditions its height is 5 feet, but this decreases as the soil becomes poorer and the rainfall more scanty. The calculated outturn per acre in Ganeshkhind was as follows :—

In 1912,	8,200 lbs.	green	fodder.	
In 1913,	119,200	,,	,,	(cut before flowering).
In 1914,	8,400	,,	,,	
	3,200	dry	,,	(same stuff dried).

The grass responds to cultivation by producing more foliage. In 1913, it was also found that stirring the soil after each cutting conserved the soil moisture to such an extent that the plants remained green up till March, 1914.

This grass is commonly believed to be very nutritious, and this belief is borne out by our original chemical analyses of the fresh grass. The results of these analyses are as follows :—

	Before flowering	In flower	In seed
Moisture	69·90	65·93	65·40
Ether extract	1·60	1·70	1·72
Albuminoids	2·14	2·24	2·00
Carbohydrates	13·46	16·30	12·81
Woody fibre	9·20	11·59	14·26
Ash	3·70	3·74	3·81

From this table it will be seen that the total dry matter is greatest when the grass is in seed. The amount of dry matter when the grass is in flower, is, however, fairly close, while in seed the amount of albuminoids and carbohydrates falls considerably and that of woody fibre increases. The best time for feeding this grass, then, is at the flowering stage.

There are three other species that also go under the name of *Marvel*. These are *Andropogon caricosus*, Linn., *Andropogon pertusus*, Willd., and *Andropogon foveolatus*, Del. These are slightly higher in nutrients than *Andropogon annulatus*, but cattle seem to relish the last named species best.

The ripe seeds germinate readily if sown in thoroughly tilled soil soon after the first showers of the monsoon. The seedlings must be well established before the heavier falls of rain.

The accumulation of information of this kind gives a solid basis of fact as to the relative values of different species. The next point is their propagation.

Here we at once meet the difficulty of obtaining seed. The only way to get seed is to get it collected by one's own employees. This is a long, expensive, and laborious business and only a comparatively small amount can be so obtained in one season. Applications by the public for such seed are numerous, but people will not take the trouble to collect it themselves. There are no firms in India that deal in these seeds on a large scale, and so individual effort in collection must for a time be the only means of obtaining such seed.

Having obtained the seed, the next question is: "Will it grow?" Germination tests in the Seed Testing Laboratory of the Poona Agricultural College have on the whole given low values for these seeds. This seemed to be due not so much to the presence of a proportion of lifeless seeds as to the fact that seeds may apparently remain dormant, even in moist ground, for very varying periods of time. The tests quoted were carried out at the break of the rains, so that if there were any periodicity in the life of the seed, it might have the most favourable chance to show itself. Even with this precaution, however, the germination percentage

was in most cases low. This matter requires closer scientific investigation.

When seeds are drilled in good soil, and the weeds kept down, the plants flourish and perennate on a comparatively low rainfall. The next point of enquiry is whether they will endure the competition of the wild plants already in possession of any area in which they may be sown. On this point the facts at our disposal are as yet scanty, and not very encouraging. It seems absolutely necessary, if a new grass or mixture is to be established, that the land must be cleaned fairly well of existing vegetation, the seeds carefully sown and rolled in, weeding occasionally done, and cattle rigidly excluded till the new growth has taken hold.

If the establishment of improved fodder plants requires all this attention, it may well be asked whether it is worth the trouble. Experiment alone can determine. When once a strong perennial grass gets hold of a suitable locality it is not easy to shift, and the labour of establishing it may be repaid. Recent experiments in the re-seeding of depleted ranges in certain parts of the United States give us hope that similar methods may not be out of place in this country.

Here in India we cannot at present consider the refinements of hay and pasture management as practised so successfully in Britain. It may, however, be possible to consider such questions as the sowing of grass mixtures along with a crop like *jowar* in order to give a greater outturn of hay and a considerable amount of grazing after the main crop is cut.

The problems connected with the improvement of natural grassland can be solved only by the co-operation of the agriculturist, the chemist, and the ecological botanist. It is not too much to hope that ultimate success will reward such combined efforts.

PADDY SEED-BEDS IN THE KISTNA DELTA.

BY

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In a country like India with its remarkable diversity of field crops varying in their methods of cultivation from district to district, it may be a sufficient excuse to give some account of the methods of raising paddy seed-beds in the Kistna, in the hope of interesting some who live outside the Presidency of Madras. As at present constituted, the Kistna district includes portions of two deltas and is irrigated by the Godavari and Kistna rivers. While the delta irrigated by the Godavari commands water for eleven months in the year, the supply from the Kistna lasts only for six months. Consequently, while in the former delta two crops are possible, in the latter the *raiyats* get one only. Sugarcane, which would otherwise suit the Kistna district well, is not grown in the delta for this reason. The method of raising seed-beds in both the tracts is different. In the localities irrigated by the Godavari, *raiyats* make small tanks about 100 feet long by 75 feet broad and 4 or 5 feet deep near the paddy lands. Before the closure of the canals at the end of April these tanks are filled with canal water, and at the same time an acre or two of the land surrounding the tank is also flooded. When the right time comes, these lands are manured, ploughed under puddle and paddy nurseries are raised. Water is baled out by swing baskets. The seed-rate here is about 28 lbs. for transplanting an acre, and 25 acres are transplanted from an acre of seed-bed.

On the Kistna side of the delta, however, where water-supply is scantier, the canals are closed in March and only drinking water

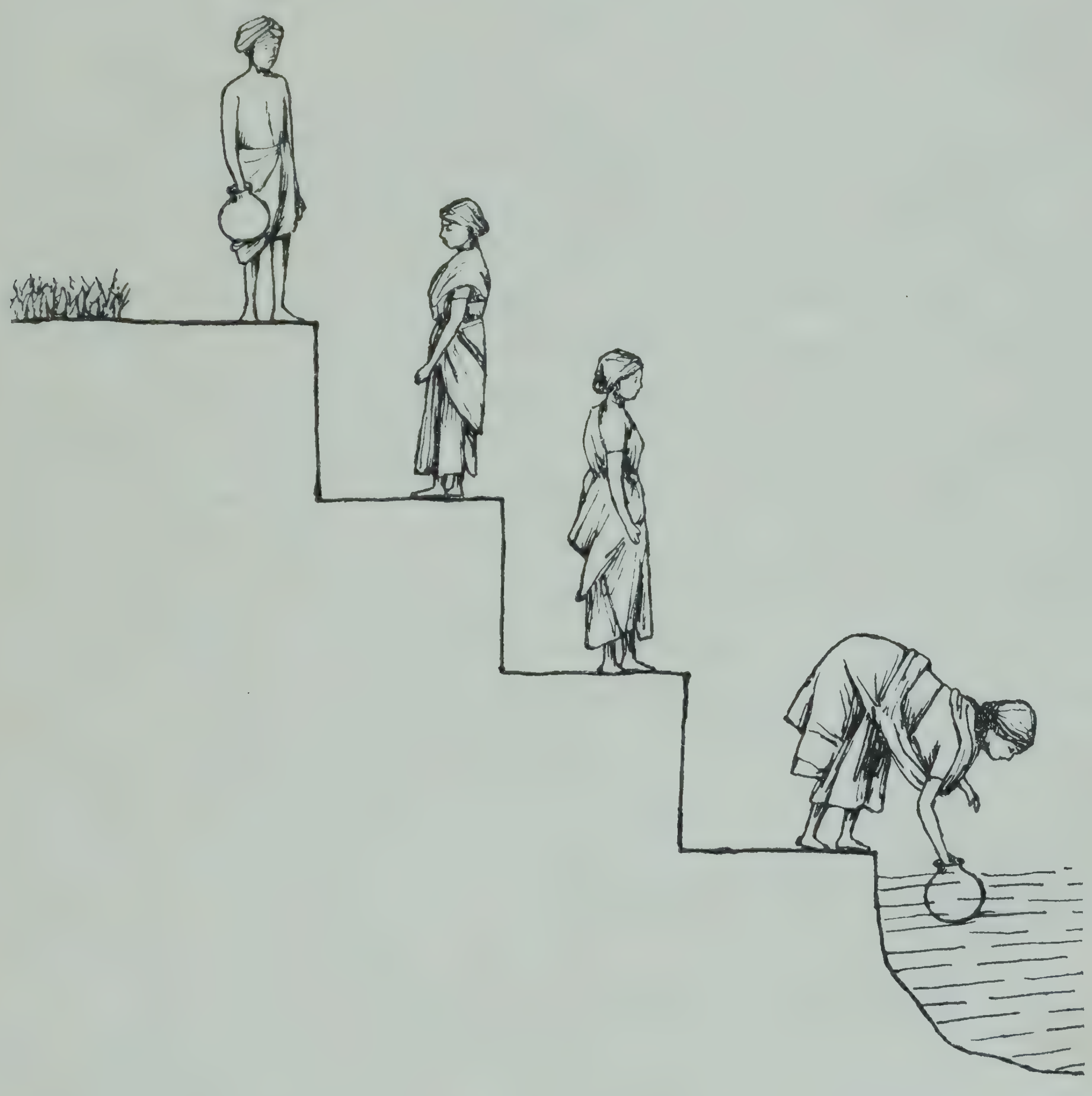
tanks are partially filled prior to the closure of the canals in March. *Raiyats* have certain areas ploughed soon after paddy is harvested, which they reserve for nurseries for the coming season. During the hot weather any chance rain is taken advantage of for ploughing these plots two or three times. These are heavily manured and on the opening of the canals in June, seed is sown and irrigated. The seed-rate is smaller, 15-20 lbs. being sufficient for transplanting an acre and an acre of seed-bed will do 40 acres of transplanting.

Although this is the general rule, wherever facilities exist, *raiyats* raise nurseries before canals re-open so that their seed-beds are ready at the beginning or middle of June. They favour early transplantation as the seedlings are much more vigorous if raised before rains take the heat off the land, despite the labour and expense.

In some taluqs early seed-beds can be grown owing to natural advantages in the situation. In Kaikalur, for instance, early seed-beds are raised in soils which are formed of silt in the bed of the Kollair lake. Such soils are got ready in May and sown at the end of the month before the opening of the canals, so that any chance rain due to the early bursting of the monsoon may start germination. In the same taluq there is a stretch of land, sandy in nature, following the Pedalanka channel for several miles where seedlings may be raised. Water is available at a high level in the hottest part of the year. Here *raiyats* dig spring wells, each capable of irrigating from 10 to 15 cents a day. There are a series of such wells which are utilized in irrigating during the months of May and June. The seedlings are hand-watered although *piccotah* could be more efficiently substituted. It is interesting to see how this practice originated in this tract. Ten years ago a *raiyat* in one of the villages visited his friends in a village in the Godavari delta where they raise seedlings under tanks. Convinced of the efficacy of the early growing of seedlings he returned home and tried it on a small scale under a well. This experiment was so successful that the practice has spread not only in that village but in many villages all along the channel.

A similar method is practised in many villages of the Gudivada and Bezwada taluqs. Several *raiyats* of the Gudivada taluq who own lands near the Kollair lake are unable to raise early seed-beds. The water-level is low and the water brackish. It is also unfortunate that such lands as are situated in the vicinity of the Kollair lake are subject to inundation, and unless they are transplanted early the *raiyats* are apt to lose their season altogether. They have to choose between the risk of losing a season and procuring early seedlings from elsewhere. Those who can afford prefer the latter. They travel down to Gudivada and its neighbourhood where facilities exist and land is available for raising early seedlings, but the prices of land rule high. A rich man who owns about 40 acres of land, the major portion of which he leases for such purposes, informed the writer that he obtains even two *candies* of paddy (about 100 rupees under current prices) as rent for an acre of seed-bed which he leases out for five or six weeks. Besides this, the lessee manures his land heavily and incurs an astonishingly large amount of expenditure in irrigating the nurseries. The irrigation source is a well: permanent or temporary. Under the former the *raiyat* uses a *piccotah* or a *mhote*, meaning by the latter a well sunk right in the middle of his nursery at a cost of about ten rupees, which he closes at the end of the season. Irrigation is often given on contract at Rs. 2 to 3 for every 15 cents of land irrigated once. Roughly the labour employed in irrigation is as follows. The well, which is about 10 feet deep, is provided with three steps on each of which two women stand on either end. Those on the step nearest the water hand the water-pots over to the two just above them, who in turn to those above them. These latter hand over to a man on each end of the well who hand-waters the field. (See Figure opposite.) Each woman is paid three annas and a man six annas a day. This is a reasonable rate considering the time of the year, but it varies according to the demand and availability of labour. By this means they can irrigate only 15 cents a day. Before being lifted the crop requires three such irrigations. The seed-bed land is afterwards transplanted in the usual course. It is also not infrequent to grow

seedlings for sale in villages where such early seedlings are in demand. Seedlings enough for an acre fetch from Rs. 5 to 12 according to season and demand. In Valloor, a large zamindary village where large wells under *mhotes* are in existence, several *raiyats* join together and raise seedlings under one well. The



Method of irrigating seed-beds at Gudiwada.

owner permits other *raiyats* to grow seedlings free under his well provided that they plough, manure, sow and irrigate with their own labour. His land is enriched by the heavy dressings of manure, and he has the satisfaction that he has done a good turn to his friends.

In the Guntur side of the delta early seedlings are raised which depend upon rain before the opening of the canals. Although most *raiyats* this side depend upon canal water for raising their nurseries, in the neighbourhood of Bapatla where a belt of sand exists, there is a class of *panchamas* who make a trade in early seedlings which are raised in the sand beds. There are Government "assessed wastes" leased out at a nominal sum. The sources of irrigation are spring wells in which the water level is very high even in the hottest summer. The land is heavily manured with sheep dung. In addition, pig manure or indigo seet is often applied. The plots are irrigated thrice a day: *Ragi* (*Eleusine coracana*), groundnuts and horsegram are other crops grown on such lands. A man owning, for instance, a thirty cent plot and selling the whole produce would obtain Rs. 40 in cash and in addition have enough seedlings left over to transplant two acres of his own land. This is the most he can make and there are seasons when he does not make any profit at all. To cite an instance: when the season is early and the *raiyats* in the neighbourhood who possess lowlying lands are enabled to raise early seedlings by means of rains, the Bapatla trader sustains a great loss as he would obtain no customers then.

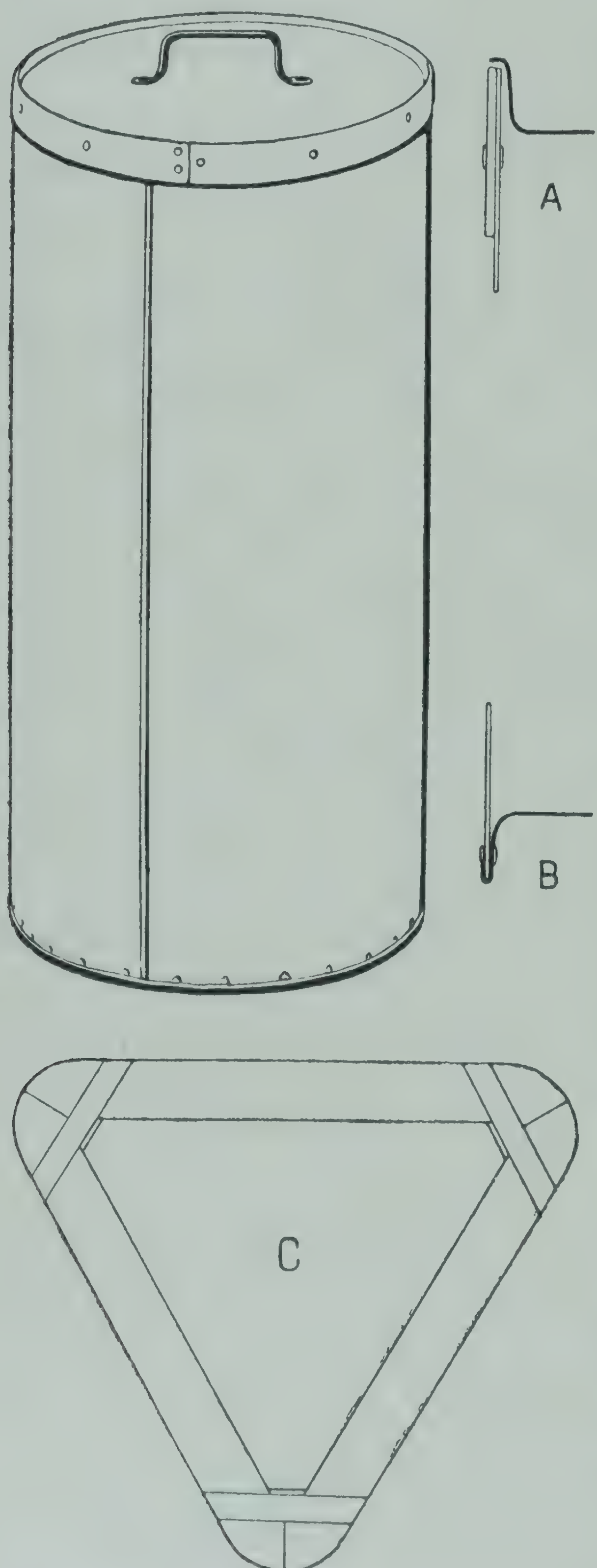
In the foregoing pages the writer has endeavoured to show not only how varied the methods of raising paddy nurseries are, even in a small area, but also, if properly managed, how profitably they could be run.

NOTES.

The storage of seed.—In the monsoon-fed areas of India, the question of seed-storage in connection with plant-breeding work is a matter of considerable importance. It is necessary, not only to keep seed during the rainy season but also to devise methods for preserving the germination capacity for several years, so that any particular culture of a series may be repeated whenever required. The experience obtained in the Botanical Section at Pusa, during the past ten years, has shown that the seeds of many of the cultivated crops of India can be preserved, for long periods without injury, provided they are first of all very thoroughly dried in the sun at harvest time and immediately put away in air-tight receptacles. Even in the damp climate of Pusa, insecticides have been found to be unnecessary during storage as well as the use of carbon bisulphide for destroying the eggs of the various grain pests. Weevils and moths, the principal pests of stored grain, are unable to attack *dry* seeds and, even if a few of these insects are sealed up with the produce, no damage occurs. Starvation in the midst of plenty is the inevitable result.

A seed bin, suitable for plant-breeding work and holding about 200 pounds of wheat, has been in use at Pusa for some years and recently a good many samples have been supplied to members of the Agricultural Department who have visited the Research Institute. In principle, these bins are nothing more than the ordinary earthen *kothis* used by the people, but they are made of the thin sheet-iron purchasable in any bazaar in the country. They were designed for Pusa by Mr. S. A. S. Bunting, formerly Agricultural Engineer in the United Provinces. The essential structural details are shown in the sketch on the next page. The bins are cylindrical in shape,

36 inches high and 18 inches in diameter. The method of constructing the lid is indicated at A and the details of the floor at B. The lid does not fit loosely but has to be pressed in firmly after the method often employed in tin canisters. To render the longitudinal seam air-tight, the thin sheet-iron is folded. The metal can be preserved from rust by coating inside and out with hot tar in which a suitable proportion of pitch has been dissolved. A number should be painted on the lid and on the cylinder and, as the lids usually fit best in one position, this should be indicated by a line. The numbers not only prevent the lids being mixed but also facilitate the search for any particular sample of seed. To prevent the condensation of moisture on the bottom of the bin, it should stand either on bricks or on a wooden triangle about an inch thick provided with rounded corners. One of the wooden bases is shown in plan at C in the sketch. After the lid has been pressed in, the bin should be hermetically sealed round the upper rim with wax which will not melt during the hot weather and which will



not crack during the monsoon. A wax mixture, suitable for the temperature at Pusa, can be obtained by melting together 4 parts of vaseline with 5 parts of bees-wax and slowly adding

2 parts of powdered resin. For very high temperatures, the proportion of bees-wax and resin should be increased.

Two obvious adaptations of these sheet-iron bins suggest themselves in connection with schemes of seed-distribution. In such operations, centres of supply have to be opened in the villages and quantities of seed stored from year to year. It is clearly of little advantage to sink a large amount of capital in permanent buildings as these are likely to be useful only for a few years during the period when a country crop, like cotton or wheat, is being replaced by an improved variety. Once this is accomplished, there is no further need for the building and it will then be necessary to open new centres of distribution for extending the area. Large sheet-iron bins, constructed on some such principle as that described in this note, could be stored in almost any village building rented for the purpose and these receptacles could be moved easily to new centres as required. The capital expenditure involved in seed-distribution work would in this way be kept small in amount and moreover would be spent to the best advantage.

A second possible adaptation of these seed bins, in distributing seed like wheat to small cultivators, lies in the use of kerosene tins. The empty kerosene tin is a well-recognized article of commerce in India and can be purchased in all the small towns and in some of the larger villages. Wheat could easily be dried at harvest time and sealed up during the monsoon in these tins, after removing the traces of oil. At sowing-time, the cultivator could purchase one or more of these units for his sowing in a form easy to transport and in a package which could be used for other purposes. Such a method might be found useful in the case of Co-operative Societies where most of the members are small cultivators. There is at present a considerable amount of waste of seed at sowing time in the plains of India, due to deterioration during storage which results in unnecessarily high seed rates. Storage in sheet-iron bins or in kerosene tins would mean a considerable saving of seed every year.—[A. HOWARD.]

A new seed-drill.—The evolution of small, cheap agricultural implements of light draught, suitable for use in India, is now taking place in Great Britain as a result of the development of small holdings in that country. The need for labour saving appliances, adapted for traction by a single, light horse, has stimulated the designers and manufacturers of agricultural machinery to supply the new demand. In addition to the heavy implements once so characteristic of British agriculture, there is now a considerable output of small, handy machines, some of which are likely to be of service under Indian conditions.

One of these new machines has been found to be of use in Experiment Station work at Pusa. In wheat growing in India, there is sometimes a need for a light drill which can sow about four acres a day with a single pair of cattle without losing too much moisture in the process. Such a machine has been tried during the last year with satisfactory results and several visitors to the Botanical Area have asked for details of this machine in connection with the sowing of wheat, oats, and paddy. The drill, which is shown opposite, is of the ordinary type and sows five rows at a time, eight inches apart. It is manufactured by Messrs. Kell & Co., of Gloucester, and is priced at £8-10-0.—[A. HOWARD.]

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AN EROTYLID GRUB IN *Thenai* AT THE CENTRAL FARM, COIMBATORE.—Early in December of last year (1914) dead-hearts were noticed in the *thenai* (*Setaria italica*) growing in the Insectary compound at Coimbatore. On examination this appearance proved to be due to the activities of the larva of an Erotylid beetle (Genus Fatua?). Larvæ, pupæ and eggs were found in different stems and adults were successfully reared.

In view of the smallness of the knowledge of the life-histories of Indian Erotylids, the following details may be of interest :—

The eggs are laid singly about half way up the stem of the *thenai* plant, generally just above a node, but sometimes higher up in the internode. The egg is laid through a hole cut through the leaf sheath and the stem. This hole does not close up and can

PLATE XVIII.

A FIVE ROW SEED DRILL.

easily be seen. The egg is cylindrical and orange yellow in colour with clear yellowish ends.

The grub on emerging from the egg first bores its way up the stem for some distance, it then returns finally reaching the node near which the eggs were laid. Here it eventually pupates. When first hatched the grub possesses a relatively very large head with powerful jaws, the abdomen is short and possesses sparse hairs on the segments. The posterior end is bent downwards and forms a clasper.

Before pupating the larva prepares for the easy emergence of the adult by "ringing" the stem for about $\frac{3}{4}$ of the circumference inside. At this point the stem easily breaks and in fact affords an easy means of identifying stems attacked by the Erotylid.

The natural enemies of this insect will probably suffice to keep it in check as it was found that an Ichneumon and a Chalcid could both be bred in large numbers from attacked stems and the majority of the larvæ appeared to be parasitised by one or other of them. The pupa of the Ichneumon is generally found about half way up the internode in which the Erotylid larva had been burrowing.—[E. Ballard.]

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In the *Bihar Agricultural Journal*, Vol. II, there is an interesting article by Mr. C. S. Taylor detailing some experiments on the ripening of sugarcane at Sabour. Samples of the *Khari* variety which is known to be an early ripener were taken and analyses of the juice were made from November to February. The average results of 10 plots are given in the following table :—

	1913				1914			
	November 1st	Mid-November	December 1st	Mid-December	January 1st	Mid-January	February 1st	Mid-February
Cane sugar (Gms. per 100 c. c.)	11·04	12·28	13·26	13·46	14·28	14·50	14·92	14·50
Glucose per cent.	2·11	1·90	1·78	1·67	1·44	1·41	1·33	1·49
Juice extraction per cent.	61·01	61·67	62·30	61·30	61·60	59·80	62·64	60·81

It will be seen that on November 1st, the cane sugar content is low and the reducing sugar known as glucose is very high. On December 1st, the cane sugar actually increased 20 per cent. while the glucose decreased about 15 per cent. Thus the result of waiting a month is an additional 8 seers of *gur* to every maund obtained in November together with an improvement in the quality resulting from the decrease of glucose which produces a sticky *gur* of low value with small crystals. On examination of the figures for December 1st, and January 1st, it will be seen that the actual increase in cane sugar during December was about 8 per cent. and the decrease in glucose about 20 per cent. of the amounts at the beginning of December. The figures from January till the middle of February show that cane sugar and glucose contents both remain almost stationary during this period and then begin slowly to decrease and increase respectively. In Bihar in all cases where cane is well grown, there is therefore great risk of loss in cutting it before the end of December. The most profitable period for cutting well-grown *Khari* cane is from January till the middle of February.

Mr. Taylor also carried out an experiment to determine whether the type of cane affects the time at which it will ripen. As was expected, great differences were found in the time of ripening of different canes. While the canes known as *Khari* and *Shakarchynia* were found to ripen very early and to give good sweet juice even as early as December, dwarf canes such as *Mango, Hemja* and *Rheora* ripened more than a month later when grown under the same conditions of cultivation. These dwarf canes, in fact, did not ripen till the middle of February and showed their maximum sugar content early in March. It would therefore seem that the judicious selection of varieties will help to prolong the period of working for a central factory in Bihar.

The author studied the question of the effect of different kinds of manure on the ripening period of the cane at Sabour and summarizes the results as follows :—

"The plots were manured with nitrogen as sulphate of ammonia, phosphoric acid as calcium superphosphate, while potash was

also added with nitrogen in the form of potassium nitrate. The only noticeable effect produced by these manures on the period of maturity of the sugarcane was shown in the plots to which sulphate of ammonia was applied. The application of this fertilizer gave a marked effect, even to the eye, on the growth of the cane, producing darker and more luxuriant foliage than in the case of the plots to which no extra nitrogenous fertilizer was applied. This green colour persisted for some time after the blank plots had begun to show the characteristic brown colour of the leaves of ripening cane, and the analyses of the samples taken from these plots illustrate these differences in the period of maturity in a striking manner. In this experiment analyses were made from the middle of November, 1912, to the middle of February, 1913, and an abstract of some of the results is given below :—

	Mid-November	Early December	Mid-December	Early January	Mid-January	Early February	Mid-February
Average results of plot treated with ammonium sulphate in grams: cane sugar (per 100 c.c. juice)	12·23	13·43	14·10	14·83	15·96	16·45	16·64
Average results of control plots in grams: cane sugar (per 100 c.c. juice)	13·33	14·06	15·00	15·00	16·29	16·25	15·61

"The most striking point about the observations, however, is the fact that the plots which were top dressed with sulphate of ammonia have only attained the same juice richness in early December, as the unfertilized plots showed in mid-November. In this way it would appear to an experimenter reaping his cane in December say, or even early January, that the juice richness of the two kinds of plots was different. On proceeding further, however, we find that while the unfertilized plots appear to have reached a maximum by January (as the slight increase of 0·22 from mid-January to mid-February is negligible), the plots which were fertilized with sulphate of ammonia show an increase right into

February, and attain almost exactly the same maximum sugar content as the other plots. This is of interest in that it indicates that the differences, shown by any particular cane in its sugar content, when grown in the same place, are probably merely phenomena of ripening due to a slight difference in fertility between one part of the field and another. The ripeness of any part of the field may simply be tested by means of an ordinary hydrometer or by means of a modified hydrometer called the Brix saccharimeter which indicates roughly the percentage of total sugars in the juice."

An interesting experiment on the effects of dates of planting on the period of maturity of sugarcane has also been brought to a close at Sabour. "In tropical countries it is frequently found that an alteration in dates of planting may produce a marked difference in the maturity. In view of the marked difference between the cold and hot seasons of Bihar with the well-marked cessation of the rains in October it was thought probable that the period of maturity of any particular cane was more determined by the character of the season than by anything else, and that it was probable that canes commenced to ripen immediately at the end of the rains without any dependence on the date of planting. Analyses were carried out twice monthly from early November until the middle of February, and consideration of the results shows no earlier ripening in the case of canes planted in November than in those planted in March. In fact one of the rows planted in March gave very stunted cane which actually came to maturity very much earlier than any of the others."—[EDITOR.]

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In the *Quarterly Journal of the Indian Tea Association*, Part IV, 1914, there is a short article on root nodules written with a view to removing some confusion as to the nature of these nodules in the mind of planters interested in green manuring. As the information will not fail to interest agriculturists in other parts of India the following extracts are here given :—

"The nodules are caused by bacteria which enter the young roots from the soil. The bacteria which occur in different species

of leguminous plants present slight differences in form, and it has been found by experiment that the bacteria-forming nodules on one host plant frequently fail to infect another plant of a different species. It would appear, therefore, that the species or at any rate the variety of bacteria causing root nodules differs with the host plant. Some legumes when introduced to a new district fail to produce nodules although they may be found on them in abundance in places where they are indigenous. The introduction of soil from the district where the plant usually produces nodules or of cultures of the variety of bacteria found in the nodules, to the soil of the new district, is followed by the normal production of root nodules.

Nodule bacteria have been frequently grown in cultures on gelatine and in solutions, and in that condition they fix nitrogen only feebly if at all. They can indeed exist without free nitrogen so that although a large number of these bacteria may be present it does not necessarily follow that a great deal of nitrogen is being fixed.

The bacteria are only present in the nodules on the roots and if they are introduced to other parts of the plant they merely die. It is by no means certain that the nitrogen assimilation takes place in the nodules. It seems probable that the fixation is rendered possible by the interaction of the bacteria with the host plant. Chemical substances, formed by the bacteria, and introduced from the nodules into the plant may render possible the assimilation of free nitrogen by the host plant itself.

However, and wherever the assimilation of nitrogen takes place it is certain that the nitrogen fixed is not stored in the nodules, but is used by the plant in the formation of nitrogenous substances necessary to its own development. It is not merely fixed and stored for the use of other plants. The error is commonly committed of supposing that the death of the nodules renders available the nitrogen fixed by the agency of the nodules bacteria. This is entirely wrong. The nitrogen fixed is only rendered available by the death and decay of the tissues of the plant, of which it forms part. The maximum benefit from a green manure crop is only obtained on the death and complete decay of the plants. The idea

that most of the nitrogen is in the roots because the nodules are borne on them is erroneous.

A comparison of separate analyses of various parts of leguminous plants shows that with the exception of the seed the highest percentage of nitrogen is found in the leaves. The following figures, taken from analyses of Boga medeloa (*Tephrosia candida*) published in the last number of this Journal, serve to illustrate this point :—

	Percentage of nitrogen calculated on dry matter.
Leaves	3·85 per cent.
Stem	0·79 ,,
Roots	0·79 ,,

The leaves and stems usually contain a greater weight of substance than the roots, so that the percentage, in the roots of the total nitrogen of the whole plant, is small.

In this case the total weight of the plant was made up as follows :—

Leaves	35·72 per cent.
Stems	57·14 ,,
Roots	7·14 ,,

Calculated from these figures, the leaves, stems and roots contribute the following amounts respectively to the total nitrogen of the plant :—

Leaves	73·26 per cent.
Stems	24·06 ,,
Roots (including root nodules)	1·68 ,,

It will be seen at once that the nitrogen is not stored in the roots. Hence the idea that the nitrogen fixed by leguminous trees such as 'sau' (*Albizzias*) is rendered available by the cutting of the roots in cultivation is wrong.

The conditions under which root nodules are formed are as follows :—First of all the right kind of bacteria must be present in the soil. Scarcity of available nitrogen in the soil, provided a sufficiency of other necessary constituents be present, favours the growth of these bacteria and the development of root nodules. Leguminous plants growing on soils already rich in available nitrogen fix little nitrogen and the production of root nodules is

noticeably restricted. If the host plant be starved in respect of other necessary soil constituents, or injured by disease or other agency, the nodules are reduced in number and size. The growth of root nodules is dependent on the good health of the host plant."

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There is an interesting article in the *Philippine Agricultural Review*, Vol. VII, No. 7, by Mr. C. W. Edwards, dealing with the introduction of Indian cattle into the Philippines not only for draught purposes but also for the purpose of upgrading the native stock.

It appears that the cattle of the Philippines have been brought to such a condition by combination of circumstances that there is a woeful dearth of both draught and beef stock in the Islands.

The usual two alternatives presented themselves ;—importation or the breeding up of the present indigenous stock.

The attempt to import and breed up English and American stock having been rendered abortive by the climatic differences and their liability to disease, an attempt was made to introduce the cattle of Tropical China and Indo-China. But their liability to rinderpest and the fact that they were not sufficiently superior to the native stock to make grading up easy, lacking the necessary size, conformation and prepotency for this work, caused this attempt to be abandoned.

Recourse was then had to Indian cattle, and it would appear that the 'Ongole' and 'Mysore' breeds were the most suitable from which to make a definite start to improve the local stock. The first importation of 13 Nellores was made in 1909 and the results from the various trials make interesting reading. In addition to their general excellence the characteristics of the 'Nellore,' which are held in particular favour in the Philippines are their practical immunity from rinderpest and their 'rustling' qualities, this latter having enabled them to survive during periods when a number of the native calves succumbed to starvation. They have also been most successful for road and light field work.

They are criticized as being too upstanding and 'rangy' and inclined to be slab-sided, but one cannot help asking if the author has ever seen a good "rustling" breed that had not these characteristics developed to some degree. They are also said to be inclined to be vicious if confined. This is doubtless a characteristic which will wear off in time.

Their meat is also of a fairly good texture, although somewhat darker in colour than that of the native breed, and in short it would appear that as a combination beef and draught breed their suitability for the Islands is little short of extraordinary.

The article is illustrated by three photographs and one is tempted to ask after reading it whether it is worth while to waste time trying to grade up the native cattle when there does not seem to be one single point in which they are not hopelessly inferior to the imported stock, and when an imported breed is not affected by the local diseases, can live when the local breed starves, and beats it in every single cattle point, it would seem to be a moot point whether the imported stock could not safely be left to take the place of the local stock in course of time, instead of reducing its own natural advantages and points by crossing with an inferior animal with nothing to recommend it.—[WYNNE SAYER.]

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THE HOLSTEIN MILK YIELD.—There is an interesting note by Mr. F. R. Marshall, in the *Journal of Heredity*, Vol. V, No. 10, in which it is shown that the careful examination of the Records in the Blue Book compiled annually from the advance register of the Holstein breed furnishes no support to the idea that the milking capacity in cows is transmitted through males rather than females and in view of the fact that among cattle breeders we find a prevailing impression that the bulls of dairy breeds generally are prepotent in the transmission of the characteristics of the females of their race, it is of considerable interest to all breeders. Sedgwick in fact may be quoted among others as saying:—"It is well known, for example, that the supply of milk by cows is hereditarily influenced by the bulls rather than by the cows from

which they are directly descended, and that the character of the secretion, as regards both the quantity and the quality of the milk is chiefly derived from the paternal grandmother * * * !

"This, if true, would fit in well with sex-limited inheritance, and such indeed it may ultimately be found to be."

From this it is obvious that the main idea of improving a milch breed would centre round the bulls and the prices obtained for the bulls of most of the dairy breeds point to this view being firmly adhered to. It is, however, worthy of remark in this connection that the Channel Island breeders pin their faith more upon descent on the female side and their pedigrees run through cows chiefly, which seems to point to the fact that the above-mentioned discovery was pretty shrewdly guessed at by most of the prominent Island breeders who made the Jersey what it is and continued to fix the type in such a wonderful fashion. It will be of interest to see if this discovery which is possibly only the forerunner of many more equally startling facts which the followers of Mendel will sooner or later place before the world, will bring about a reduction in the price of the bulls of milk breeds and will cause more attention to be paid to the type of cows in a herd.

To sum up: the difference between 0·157 which is the figure for percentage of butter fat transmitted on the paternal side and 0·155 transmitted on the maternal side does not in any way bear out the immense superiority which is claimed for the progeny of a first class dairy herd bull and it would appear that all the milk-yield factors are linked with these figures.—[WYNNE SAYER.]

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The Superintendent, Government Gardens, Nagpur, and the Economic Botanist, Central Provinces, have published a few hints on orange cultivation in the *Agricultural and Co-operative Gazette, Central Provinces*, Vol. X, Nos. 6 and 12. The most favourable conditions for the growth of the Nagpur orange are a fairly dry atmospheric condition, an elevation of 900 to 3,000 ft. above sea-level and a well drained soil. If the climate is suitable they will do well in almost any good soil from heavy black to sandy loam.

Both the authors point out, however, that there should be no water-logging as oranges are particularly sensitive to water standing round their roots. If the land in the garden is not properly graded they advocate the opening of deep surface drains, under-draining either by boulders or porous earthenware pipes being costly. Nagpur *santra* is entirely propagated by budding and the stock used are the sweet lime and the common citron. The rainy season is a good time to plant, but where water is plentiful the trees may also be planted any time during the cold weather. The best distance for Nagpur orange trees is recommended as 18 ft. from tree to tree in the row and also 18 ft. between the rows. It is pointed out that in planting a new orange garden the pits for the new trees should not be less than $3' \times 2' \times 3'$ so as to give the new roots sufficient room to spread. As these trees are raised by budding, they have a tendency to produce too many branches. The necessity of severe pruning, when the plant is young and until it has formed a strong main stem without branches to a height of 3 or 4 ft. above ground, is therefore emphasized. It must be remembered that these trees cannot be pruned once they are big. The ideal orange tree should be in shape like an umbrella with a clean stem rising 3 ft. clear of the ground and a dome-shaped crown.

Both the authors condemn the existing method of irrigating orange trees. In most orange gardens water is run into a saucer at the foot of the tree. The result of this is that all the roots are confined to a small area. The furrow system of irrigation is decidedly superior. In this system water runs into a circle round the tree, the circle gradually becoming further and further from the tree as it gets old till ultimately the water is given in straight furrows between the rows. The feeding roots of the tree are thereby encouraged to spread, more food material is brought within reach of the plant and all the field is made use of by the trees. Another advantage of the furrow system of irrigation is that it is more economical in the amount of water used, roughly about one-quarter the amount of water is required to irrigate the furrow as compared with the saucer method. A further saving is effected

by covering the water channels with loose earth the day after irrigation has been carried out. The loose earth in the *nullah* acts as a blanket and prevents the water drying out and so being wasted. When the time for irrigation comes round again it is easy to remove the loose earth and open out the *nullah*. By doing this it is only necessary to water the trees once in three weeks even in the hot weather instead of once in 5 to 7 days.

The natural flowering time for the orange is February but by withholding water for 5 or 6 weeks just before the rains break and also by exposing the surface roots, the trees are made to flower in June in the Nagpur district. This bad practice leads very often to a diseased condition of the tree finally resulting in death.

The insect pests of this crop and their remedial measures form the subject of an article in the February (1915) number of the same Gazette which will be of some interest and use to those connected with the cultivation of this fruit crop.—[EDITOR.]

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The *Bulletin of the Imperial Central Agricultural Experiment Station, Japan*, Vol. II, No. 1, has an article by Mr. T. Katayama, pointing out the value of the stem and leaves of Sweet Potatoes as a nutritious fodder for stock. In Japan while the plant is cultivated for its tubers, the stem and leaves are little used as fodder. The importance of this crop will be seen from the fact that there are 698,900 acres of it in Japan producing about 3,000,000 tons of sweet potatoes annually. Mr. Katayama estimates the aggregate weight of stem and leaves at 5 tons per acre. His experiments showed that fresh stems and leaves of the "Sweet Potato" are a rather "watery" fodder resembling in composition the leaves of the sugar-beet, containing tannin, instead of oxalic acid. No bad effects were noticed from the exclusive feeding of these when given green and fresh and though it is specially mentioned that, in some regions, milch cows and pigs are fed, for long periods, with large quantities of the fresh material with the best results, the farmer is advised to be cautious and to

mix the green material with an equal quantity of dry hay or straw.

It is, however, the dried material which the author particularly wants to bring to the notice of stock owners. The air-dried herb has a fine "aroma" and is so readily eaten by stock with such good results that it has led him to believe its feeding value to be equal to that of dry hay of fair quality.

To prepare the dried material, the green herb should be gathered, when the tubers are lifted and then be spread out to dry in the air. In his experiments he spread the stems and leaves thinly on straw mats and obtained a straw of fair consistency within 10 days of fair weather, with an average day temperature of 13° to 19°C. (=55·4° to 66·2°F., respectively). The dried material should be stored as soon as air-dry so as to avoid leaching and deterioration of the leaves.

Mr. Katayama has also proved by experiments, that fine ensilage of this herb can be produced in approximately 5 months. The green material should be first reduced to small pieces and then the silo should be filled in the usual manner, admitting as little air as possible. The resulting silage will be pleasant in smell and wholesome in its effects on stock. The loss in nutritive material, suffered by the ensilage in the process of fermentation, is small amounting only to about 6 per cent. The exact quantity required for immediate feeding to the animals should be taken out of the silo as it is not improved by keeping.

In India, the use of stems and leaves of sweet potatoes as a cattle fodder is not unknown. The crop is grown all over the country, and the vines, after the tubers are lifted, are fed to cattle. The area, however, under the crop being not very extensive, the question of storage of this fodder in a dry state does not arise, the more so as there are various other fodders such as wheat straw, *kadbi*, grasses, etc., which are dried and stored.—[EDITOR.]

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INDIAN MOWRA SEED.—The *Bulletin of the Imperial Institute, London*, draws the attention of British oilseed crushers and makers of edible fats to the utilization of the Indian *mowra* seed which

used to be largely exported to Germany but are now available at comparatively cheap prices on account of the closing of that market as the result of war. For several years Germany has been the chief purchaser of India's exports of this product, and last year (1913-14) over 85 per cent. of the *mowra* seed shipped from India went to that country.

The following table shows the total exports of *mowra* seed from India, and the quantity and value taken by Germany :—

	Average for three years ending 1911-12.		1912-13.		1913-14.	
	Quantity cwts.	Value £	Quantity cwts.	Value £	Quantity cwts.	Value £
Exports to Germany ...	407,228	185,710	187,054	100,020	567,670	309,791
Total Exports ...	664,942	303,709	265,861	142,913	665,979	364,000

Mowa or *mowra* seeds are the product of species of *Bassia* which occur throughout the East Indies, and yield fats suitable for edible purposes. In India the fat is expressed from the kernels of the seeds and is eaten. An account of the investigation of samples of *Bassia* kernels and fats from India and Ceylon was published in the *Bulletin of the Imp. Inst.* (1911, Vol. IX, p. 228). This seed has so far received little, if any, attention from British oilseed crushers. Probably an important reason why *mowra* seeds have been disregarded by British oilseed crushers is that the cake is not suitable for feeding to stock, and can only be used as manure. In view of the possibility of supplies of these seeds, which would in normal times have gone to Germany, becoming available at advantageous prices, it would seem that an effort might be made by those engaged in the British Industry to capture this trade.

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We have received from Capt. J. W. Petavel, Organizing Secretary of the Educational Colonies Association, Cossimbazar, a prospectus of a self-supporting industrial colony to be established at Berhampore under his immediate charge and under a committee presided over by the Hon'ble the Maharaja of Cossimbazar who is its founder and patron. The object is to

form an industrial and educational organization in which young men and boys of the middle class will be trained to support themselves and pay for their training by their labour and in which it is hoped they will be able afterwards to remain earning good remuneration and forming the nucleus of an industrial and agricultural organization on the co-operative principle. After a year's training they will, however, be free to leave if they find that the experience they have gained opens up better prospects for them elsewhere. A limited number of suitable pupils are to be provided with free board and also exempted from all charges from the beginning. The charge for board in the case of others will be Rs. 8 per month but, as it is expected that after three months all pupils should be able to earn their bread by their labour the question of maintenance should be well within the scope of even those of the most moderate means.

About ten pupils will be taken for training in scientific agriculture. The general plan of training is stated to be six hours' practical work each day and one and a half hour's literary and theoretical instruction in the evening. As we have not received further details regarding the qualifications of the staff and the nature of the training to be given to the pupils in scientific agriculture we are unable to criticize the scheme in this respect or offer any suggestions.—[EDITOR.]

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In the *Journal of Comparative Pathology and Therapeutics* for March, 1915, Mr. Gaiger of the Indian Civil Veterinary Department publishes a revised check list of the animal parasites of domesticated animals in India. A preliminary check list was published in 1910 in the *Journal of Tropical Veterinary Science*, Vol. V, No. 1. This has now been considerably added to, revised and corrected and the older names by which the parasites were known have been replaced by their more recent names. Both internal and external parasites are enumerated. Among the external parasites are included Ticks, Diptera, Leeches, Fleas, Lice, Mange parasites and cutaneous filaria. The list will not fail to be of use to officers of both Agricultural and Veterinary Departments.—[EDITOR.]

REVIEWS.

Agricultural Engineering in the Bombay Presidency, issued by the Government of Bombay. Price As. 2. Printed at the Government Central Press, Bombay.

UNTIL 1909 the work of supervising well-boring and pumping plants, and indeed the whole engineering aspect of agriculture in Bombay had been in the hands of the ordinary staff of the Agricultural Department. "But in that year it was finally recognized that the Department had gone too fast, at least in the matter of power plants, without adequate expert advice. Accordingly, towards the end of the year, the services of Mr. A. A. Musto of the Public Works Department were lent to the Director of Agriculture, and that officer at once set to work to organize a special engineering branch of the Department. In three years such valuable progress was made that the appointment of Agricultural Engineer was made permanent. Its present incumbent, Mr. W. M. Schutte, is a specially selected expert and took charge of the post in January, 1913." His work consists in giving advice regarding new engineering projects and existing installations and in the provision of a training school and workshop where cultivators and others will be taught for a nominal fee the proper way of attending to power plants and improved agricultural implements. From among those more completely trained, drivers for Government and private plants will be selected.

One of the achievements of the engineering department up to date is an improvement made by Mr. Musto on the Cawnpur type of well-boring apparatus, enabling trap rock to be economically bored, thus rendering boring in the Deccan practicable. With the help of this apparatus the indications of water given by Mansfield's

automatic water-finder have been put to the test, and in view of the general interest taken in this instrument, we reproduce verbatim the information given in the pamphlet:—

"This is a rather costly and delicate instrument, which, by the deflection of a magnetic needle, shows, according to its makers, whether there is water beneath the spot where it may from time to time be located. The experiments of the Department tend to prove that its makers' claims are not unjustified, and that while a certain amount of practice in using it is necessary, the instrument is not really difficult to employ. The actual observations take time and demand patience rather than skill, but the interpretation of the indications obtained requires considerable experience. Another difficulty has been the impossibility of verifying its indications in more than a few instances by ordinary digging. This has been especially the case in areas of trap rock.

"The use, however, of Musto's patent boring plant in conjunction with the water-finder has been attended so far with great success, and several bores have been put down on the basis of its indications. In three of these, up to the time of writing, a sub-artesian supply was tapped, and in one instance the water rose a distance of 60 feet up the bore. But it must be noticed that the finder appears to be of no use except in detecting flowing water. It gives no indications whatever in Gujarat where water is known to exist but where it is probably not flowing. In the areas where water is probably in fissures and flowing, the water-finder promises to be an important adjunct to the work of the boring plant in indicating the most likely sites for successful work."

Further on it is stated—

"Bore-holes have recently been made in the Deccan trap and the results have been highly satisfactory. In every case, but one, where a boring has been made, water has been found, and in four cases sub-artesian water was struck, varying in capacity from 120 gallons to 1,500 gallons per hour.

"Probably the most striking feature of these results is that the water tapped is not stagnant but flowing. Take, for instance, a bore-hole 100 feet in depth and 3 inches in diameter. Such a

hole, when full, holds approximately 30·5 gallons of water, a quantity useless either for irrigation or household purposes, but when flowing yields a supply of real value for both these purposes. This can be proved by instancing bores taken at Karmala, Sholapur district, with a flow of 1,500 gallons per hour, at Mohal, Sholapur district, with 1,500 gallons per hour, at the Bund Garden Road, Poona, with 720 gallons per hour and at Ganeshkhind Road, Poona, with 130 gallons per hour."

It must, however, be pointed out with reference to this latter statement, that much larger supplies of water have been obtained through smaller pipes in the Gangetic alluvium, where there is no reason to suppose that the water can possibly be flowing before being tapped by the boring,—except in so far as the slow percolation through sandy strata towards the rivers can be termed a " flow." In these cases the supply is large because it is obtained from a sandy stratum in which a cavity of considerable superficial area is made, so that even a comparatively slow percolation gives a large supply of water.

It is doubtful whether underground water can ever be stagnant, as it must usually have an outlet somewhere towards which it flows more or less slowly, and it would seem probable that the supply obtained from a boring in rock depends more on the extent of fissures tapped than on the rate of flow in the fissures previous to boring. The fact possibly is that the water-finder is incapable of indicating a uniform flow of water in a homogeneous stratum of any extent—which would make it almost useless in alluvial plains, or even over any large sub-artesian reservoirs that may be embedded in the Deccan trap as suggested by Mr. E. Vredenburg in Vol. XXXII, Part I of the *Memoirs of the Geological Survey of India.*

The Agricultural Engineer receives a large number of enquiries in connection with the installation of power pumps, of which it is computed that there are some 130 in the Bombay Presidency. As a result of 91 such enquiries received in 1912-13, five plants have been erected and the owners trained to drive and attend them, and eight more are in process of erection.

The pamphlet also advocates the installation of sugarcane and oilseed crushers, small cotton gins, grinding mills, rice hullers, and other machinery to be driven by pumping engines during intervals when pumping is not required.

As regards the steam ploughing tackle purchased in 1913 for experimental purposes out of funds provided by the Sir Sassoon David Trust Fund, it is stated that the first year's working has been a financial success. The tackle was hired out for ploughing land in the Dharwar district and 770 acres were ploughed to a depth of 16 to 18 inches and a profit of Rs. 607 realized on the season's working after providing for interest, depreciation, and repairs. As a result of this success the Bombay Government have decided to obtain a similar set of tackle for Gujarat.

Altogether the results recorded in this pamphlet appear to have more than justified the appointment of an Agricultural Engineer in the Bombay Presidency.—[A. C. D.]

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The International Institute of Agriculture: Its Organization, its Work, and Results.—Published at the Printing Office of the Institute in Rome, 1915.

THIS publication printed in English and illustrated with 26 photographs, is well worthy of perusal by every body who appreciates the value of organization and co-operation in agriculture. It describes how the Institute came into being, how it is managed and what work it does.

The idea of having an International Institute of this sort originated in the mind of Mr. David Lubin, a citizen of the United States. It was warmly taken up by His Majesty Victor Emanuel III of Italy and steps were taken to invite the representatives of all nations to an International Conference in Rome with the object of realizing it. The Conference met in Rome on May 28th, 1905, all the great Powers and most of the others being represented. The conclusions arrived at are embodied in the Treaty of June 7th,

1905, creating this Institute. Forty Governments and fifteen States and Colonies have given their adherence to the principles and objects of the Treaty. The duties of this Institute as defined in Article 9 of the Treaty are shortly, to collect, study, and publish information concerning farming, vegetable and animal products, and markets, indicate the wages paid for farm work, make known the new diseases of vegetables and the remedies for the same, study questions concerning agricultural co-operation, and submit for the approval of the Governments concerned measures for the protection of the common interests of farmers.

The work of the Institute is divided among four bureaux:—(1) General Secretary's Department and Library, (2) General Statistical Bureau, (3) Bureau of Agricultural Intelligence and Plant Diseases, and (4) Bureau of Economic and Social Intelligence.

The library of the Institute contains upwards of 33,000 volumes and 28,000 pamphlets. It regularly receives about 2,300 fresh periodicals.

A Bureau of Agricultural Legislation has been opened since 1911. It collects documents relating to agricultural legislation and publishes a year-book giving the full text of the most important laws and regulations relating to agriculture promulgated in the preceding year. Three issues have been published.

The Statistical Bureau aims at providing farmers with the most important figures relating to production and the markets. It collects reliable data regarding the state of crops throughout almost the whole world, the estimated and the actual harvests, wholesale and retail prices, etc., and publishes them in the (1) Monthly Bulletin of Statistics, (2) Year Book of Agricultural Statistics, or (3) special Monographs.

The Bureau of Agricultural Information and Plant Diseases is intended to keep farmers informed in regard to the progress made in agriculture and its allied sciences. This it does through a Monthly Bulletin of Agricultural Intelligence and Plant Diseases published in five languages and whenever necessary, through monographs on current questions. As this Bulletin has been several times reviewed in this Journal a detailed description is not required

here. Suffice it to say that besides including abstracts of the principal articles and reviews published in all the important periodicals bearing on agriculture and its allied sciences, it contains valuable original articles by men of science who are specialists in their line. The two special monographs issued from this Bureau are (1) on the Present Organization of the services for the control of Plant Diseases and Insect Pests in the different countries, and (2) on the world's Production and Consumption of Chemical Manures.

The Bureau of Economic and Social Intelligence endeavours to keep farmers in touch with the progress of institutions relating to co-operation, credit, insurance and thrift. Three publications issue from this branch :—(1) Monthly Bulletin of Economic and Social Intelligence, (2) Monographs on special subjects, and (3) Communications to the Press. The Monthly Bulletin gives a review of all the important events occurring in the field of agricultural economics, and is particularly useful to those officials who are guiding and shaping agricultural policy and to all who are interested in co-operation. The special Monographs on agricultural co-operation in various countries published by this Bureau may with advantage find a place in the library of every intelligent co-operator.

A perusal of this pamphlet will not fail to convince the reader that the Institute has so far done much solid work and its utility is likely to increase in future.—[EDITOR.]

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Report on the Oil Pressing Industry of the Bombay Presidency.—By Y. G. PANDIT. Printed at the Government Central Press, Bombay, 1914.

THIS report owes its inception to a Resolution of the Government of Bombay dated the 12th July, 1912, in which it was decided to institute a survey of the oil-pressing industry in that Presidency, and this work was entrusted to Mr. Pandit who has had considerable experience of the industry both in the United States and in this country. The report is of unquestionable value to those engaged in the oil-pressing industry, putting forward as it does a

number of useful and practical hints derived from the writer's experience of both the organization and the working of various seed crushing factories in America. It should also prove of particular utility to those who think of setting up new oil-pressing mills for cotton seed, as the writer has not only made valuable recommendations but also given a detailed description of the uses to which the products and by-products of cotton seed can be put, and, has clearly and in a business-like manner brought out the causes which have led to the failure of the several attempts to establish this industry in Western India. The value of the successful utilization of by-products cannot be overestimated. Many an industry now makes more money from its by-products than from the commodity it was originally started to deal with. The attention of the capitalist is also drawn to the wide field of development and the great possibilities which await the establishment in this country of factories for the extraction of oil provided they are equipped and organized on thoroughly sound modern lines. Particular stress is laid by the writer on the possibility of producing in India the best edible oil from cotton seed and of utilizing the refuse oil, which is left over in the process of refinement, for the manufacture of soap. To those concerned with the agricultural development of this country the following extract regarding the by-products of this industry, *viz.*, the oil-cakes which can be utilized for stock-feeding and also as manure is rather painful reading.

"The cake manufactured by factory method is being exported to foreign countries such as Germany, France, England, Belgium, Italy, etc. The chief reason for so doing is that there is such a great prejudice started by the *Telis* and others that this oil-cake is not suitable for feeding or manurial purposes. The cake produced in the country *ghanis* secures a price in some respects almost 50 per cent. higher than the other cakes received in Europe. As a matter of fact there is practically no difference in the manurial purposes of the cake whether produced by machinery or in country *ghanis*. Same is the case as regards the feeding value of cake, because about 7 per cent. of oil or carbo-hydrates is essential as feeding value for the animal system. Over and above 7 or 8 per cent.

of carbo-hydrates is a waste for feeding purposes to the cattle. Of course, the form of the *ghani* cake is different from the machine-made cake, but that should make no difference as a feeding value."

The neglect in taking advantage of this cattle feed and manure which is locally available and the supplies of which are likely to steadily increase amounts to a most serious economic error not only from the point of view of the farmer but also the capitalist, as he is bound to be discouraged at finding no home market for one of the principal by-products of his factory. To remedy this state of things Mr. Pandit suggests that the Agricultural Department should make special efforts to overcome the local prejudice against machine-made oil-cake by means of demonstrations on its model farms. He also recommends the purchase and distribution to agriculturists of oil-cake by agricultural co-operative societies. According to him the *raiyat* believes that his cattle can be better nourished on cotton seed fed whole, whereas this is really an economic waste, it being useless for cattle to consume more than 7 to 8 per cent. of carbo-hydrates.

Granting that India, by exporting oil-seeds to Europe in such large quantities, is removing from the country the valuable nitrogen fertilizer provided by these seeds and that against this it may be argued that the practice of feeding whole cotton seed to cattle does result in this nitrogen finding its way back, nevertheless it cannot justify any statement that this practice as it stands is economically correct farming.—[W. S.]

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Text-Book of General Therapeutics for Veterinarians.—By Eugen Fröhner, Professor of Pathology and Therapeutics, Berlin. Authorised translation by Louis A. Klein, Professor of Pharmacology and Veterinary Hygiene, University of Pennsylvania. Published by J. B. Lippincott & Co., Philadelphia and London. Agents in India: Thacker, Spink & Co., Calcutta. Price 12*s.* 6*d.* net.

This volume is a translation of the fourth German edition; the translator in his preface refers to the lack of a similar work

in English and the popularity of the German editions and expresses the hope that the present edition will prove equally serviceable to English and American Veterinarians. Both practitioners and students will certainly find much in this text book to interest and help them; the subject is treated systematically and clearly but without unnecessary detail so that its reading is pleasant and reference easy.

In addition to chapters dealing with the general therapeutics applicable to diseases of the various parts of the body, there is an interesting account of the "History of Therapeutics" with brief descriptions of the several theories that have been advanced to explain disease processes and the methods advocated for their counteraction.

The important subject of "Disinfectants and Antiseptics" is treated very fully and ably; the German Veterinary sanitary regulations are given and since they are largely applicable to other countries, will repay careful study.

The section on "Vaccination, Immunisation and Inoculation" gives a concise account of this wide and important branch of therapeutics; the principles involved are explained clearly and in sufficient detail to enable the clinician to understand the rationale of the various vaccines, sera and diagnostic agents that bacteriological research has placed at his disposal for the control of animal diseases.

Other sections deal with Hydrotherapy, Massage, Electrotherapy, Bleeding, and Air as a Remedy; in these the practitioner will find many new and helpful ideas.

We can confidently recommend this work to Veterinarians as a lucid and up-to-date account of the therapeutics applicable to domesticated animals and one which will assist them in dealing with the various problems that are constantly being submitted for solution in their daily practice.—[A. W. S.]

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In the last November and December issues of the *Bulletin of Economic and Social Intelligence, Rome,* Mr. F. Noyce, I.C.S.,

Under-Secretary to the Government of India in the Revenue and Agriculture Department, contributes an article of 27 pages on Land Revenue Administration and Tenures in British India. The standard works on this subject, consist of three massive volumes by Baden Powell of some 700 pages each, backed up by the chapters of the Imperial Gazetteer of India dealing with Land Revenue and Rents, Wages and Prices and the Resolution of the Government of India on the Land Revenue Policy, 1902. On looking at Mr. Noyce's article it will at once strike the reader that the compression of such a mass of information into an intelligible account suitable for a short article of some 27 pages is in itself an accomplishment of some magnitude. And so well has the author arranged the subject matter and so admirable and precise is his method of dealing with it that he has managed to give within these limits a conspectus of the whole subject. He treats the subject under three main heads: (1) the tenure of land relative to the State, (2) the relations of tenants to the landholders, *i.e.*, to the persons who have direct relations with the State, and (3) a brief account of the land revenue administration. Mr. Noyce's account of the deductions made by the State in its land revenue settlement, with a view to favour agricultural improvements as given below should be of particular interest to the readers of this Journal:—

"The second class of deductions of a temporary nature are those the object of which is to favour improvements, such as the construction of wells, irrigable channels or tanks (artificial reservoirs) carried out by a land-holder at his own expense. In Madras and Bombay, all such improvements, whether effected by the cultivator entirely from his resources or with the assistance of a loan taken from the State, are exempted in perpetuity from assessment. In the *zamindari* provinces the State has not, however, similarly surrendered all share in improvements. The principle followed is that additional assessment should not be imposed until the private labour or capital expended upon them has had time to reap a remunerative return. In the Punjab, Bengal, and Bihar and Orissa, the term of exemption has been fixed without reference to the term of settlement at 20 years for masonry wells, five years

for canal distributaries and 10 years for other irrigation works. In the United Provinces and in the Central Provinces, irrigation works not constructed by Government are exempted for the term next following their construction. As the term of the settlement in the former provinces is 30 years and in the latter 20 years, this means that the average period of exemption in the one case is 45 years and in the other 30 years. The rules of all these provinces provide for the grant of longer terms of exemption in special cases."

In short the article is definite and concise to such a degree that even those who have no first-hand knowledge of India will derive from its perusal a clear idea of the policy which guides the Imperial and Provincial Governments in connection with this all important subject, how and on what principles settlement is carried out and such other cognate matters.—[EDITOR.]

PROBLEMS OF A RURAL MILK SUPPLY.

THE KEEPING QUALITY OF MILK AND ITS TRANSPORT.

BY

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AND

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This note is a synopsis of the results attained in some 16 experiments dealing with the keeping qualities and suitability for transport of various kinds of milk, carried on at the College Dairy, Nagpur, in the hot weather of 1915. These experiments were originally started with a view to elucidating the problems arising from the possible establishment of rural milk supplies outside Nagpur, in which the majority of the stock employed would be buffaloes; and as very little was known as to the keeping quality and capacity for transport of buffalo milk under hot weather conditions, it was felt that any information on these subjects would be of great help. During the process of these experiments the maximum shade temperature varied from 102°—110° Fah. The diurnal variation in the dairy room was 85°—92° and in the galvanized iron shed from 84°—109° Fah.

The enquiry was divided into two sections:—1. Keeping capacity; 2. Suitability for transport—the results of which were combined in the concluding experiments. The writers do not profess to have established any facts, not already known to those engaged in dairying at any rate in the first section, though the statements

may prove of some interest as expressing in tabular form the effects of different milking conditions, different temperature conditions, and different treatments of milk under Indian conditions. As regards transport the writers are not aware of any previously published information on the problems associated with the road transport of buffalo milk for sale as whole milk, and such facts as they note and such deductions as they make may be of interest.

I. *Keeping quality in milk in relation to the time required for transport.*

The milk experimented with was buffalo milk. Experimental work was divided into :—

(*a*) A comparison of the effects of different milking methods ;

The two methods adopted were :—

(*i*) Milking as practised at the College dairy, the animals being carefully cleaned before being milked on a clean platform, on which dust has been laid, milking being done into sterilized closed pails through a filter, the milkman washing before milking.

(*ii*) Milking as practised in an ordinary dairy, the animals receiving no special cleaning attention, milking being done in the stall into open pails which have been only washed out and not sterilized.

(*b*) A comparison of the effects of different conditions under which, after milking, the milk was kept.

The two conditions of storage during experiment were (i) the dairy store room, and (ii) a galvanized iron shed.

(*c*) A comparison of different methods of treating milk produced under and kept under the above conditions.

The milk was treated in four ways :—

(1) Untreated, *i.e.*, set aside as received from the buffalo.

(2) Cooled to 40° Fah. at milking and then set aside.

(3) Cooled to 40° Fah. and fitted with a muslin jacket connected with a water supply, and being thus maintained at a temperature about 70°—76° Fah. throughout the time under observations.

(4) Pasteurized to 160° for 10 minutes, cooled to 40° Fah. and then set aside.

During the experiments acid readings were made at milking 6—6-30 A.M., at noon, 3 P.M., 6 P.M., and next morning. The potability of the milk and the character of curd formed were carefully noted. In all experiments the milk was studied in duplicate samples.

The figures below give the average increase of acidity over that present at the time of milking in conditions of storage (i) and (ii) milked in two methods (*i*) and (*ii*) mentioned above. It will thus be seen that each figure is the average of 4 samples dealt with by treatments (1), (2) and (4) above.

Time	Untreated Milk		Cooled Milk		Pasteurized and Cooled	
	Good condition	Ordinary	Good condition	Ordinary	Good condition	Ordinary
After 5 hours ...	0·05	0·085	0·0	0·055	0·0	0·0
,, 8 hours ...	0·285	0·43	0·01	0·4	0·0	0·0
,, 11 hours ...	0·433	0·87	0·26	1·1	0·25	0·23
,, 24 hours ...	9·06	8·9	7·67	7·8	8·2	7·6

A study of these figures will show the pronounced effect of the milking conditions on the keeping quality of untreated and merely cooled milk and the advantage shown by pasteurization when the milking condition is of uncertain character. The curds formed were also indicative of the effect of contamination at milking. In three cases out of four in experimental methods (1) and (2) under good milking conditions the curd eventually formed was a pure lactic one or nearly so. Under ordinary milking conditions in none of the 4 cases in experimental methods (1) and (2) were the curds formed of lactic character ; all showed the introduction of a number of other forms of bacteria.

Pasteurization appeared to neutralize entirely the defects of milking conditions. In this case the condition in which the pasteurized milk was kept, as indicated in the next group of experiments, appeared to have the most effect. Up to 8 hours the milk remained apparently unaffected in either condition of storage and from either

milking source, after this in the hotter condition of storage deterioration was rapid and the curd was formed by 11 hours after milking.

The general showing of this experiment with regard to transport, is the importance of a really good milking method for all milk to be issued untreated or cooled, the value of pasteurizing and the dependence of the distance of possible transport on the milking conditions.

The next group of figures give the increases of acidity over the initial acidity, in conditions of storage (i) and (ii) in the 4 experimental methods of treatment, the milk in each case being milked under good conditions.

Position	1 Untreated		2 Cooled		3 Cooled and kept cool		4 Pasteurized and cooled	
	(a) Good ordinary	(b) Hot about 12°–18° above (a)	(a) Good ordinary	(b) Hot 12°–18° above (a)	(a) Good ordinary	(b) Hot 12°–18° above (a)	(a) Good ordinary	(b) Hot 12°–18° above (a)
After 5 hours ...	0	0·4	0	0	0	0	0	0
,, 8 hours ..	0·1	0·47†	0	0·03	0	0·05	0	0
,, 11 hours ...	0·27†	0·6*	0·17	0·36†	0	0·05	0·1	0·4*
,, 24 hours ...	9·9*	8·22*	6·45*	8·9*	0·2	1·2*	8·6*	7·9*

Each figure is the average of two samples.

* Samples definitely unpotable. † Samples unfit for sale.

The differences in keeping quality as measured by acidity are striking under the different methods of treatment and storage. In experimental method 1, condition of storage (ii) the milk has begun to sour (though not to taste) in under 5 hours. In experimental method 3 condition of storage (i) the milk is still fit to drink 24 hours later. In treatments 1, 2 and 4 we have in 24 hours a highly developed curd, under treatment 3 in one case (both samples) the milk is fresh, and in the other only curdles on warming. Throughout the experiments the curds in condition of storage (i) were lactic, while in condition of storage (ii) they were of a more varied type. Treatment of the type 3 apart from its better keeping effect is in many respects (except from tubercular animals) safer than type 4, the next best keeping sample, in that the latter process principally kills off the lactic or souring forms, which act as a check on other types and a ready index of potability.

There are two factors in the successful care of milk—the care which should be given by the producer, *viz.*, his need to deliver the milk in a suitable condition, and the care given by the consumer after receipt. Care in milking conditions and in treatment afterwards so as to allow of the delivery of the milk in the same bacterial state as when drawn from the cow is the concern and duty of the producers.

Position of storage in these experiments was in part arranged so as to study the effects of temperature between milking and sale and in part to illustrate the effect of the care given by the customer, though in this respect it only represents one of the ways whereby the life of the milk may be lengthened or reduced.

It will be seen that the effect of the methods of treatment on keeping quality comes out in the order 1, 2, 4, 3. Apart from other important influences, discussed later, these represent the treatments to be given in ratio to the time between milking and sale.

For the time being, assuming that the journey from the producer to the customer be by rail with the least amount of shaking, treatment (1) is only adaptable (allowing a safe limit) to a three-hour margin between milking and delivery, and in the hottest weather or under less careful milking conditions a shorter period becomes the necessary limit of safety, in order to deliver the milk with the same acidity as when drawn from the cow.

In treatment (2) five to six hours may elapse, in treatment (4) seven to eight hours, and in treatment (3) eleven or twelve hours. Thus the producers' care with regard to the treatment, accorded to milk after being drawn, must vary with the length and time of journey, the temperatures to which it will be exposed between milking and delivery and (if we introduce the findings of the earlier section of experiments) to the conditions under which milking is done.

Turning to the customer whose milk is delivered in sound condition, the length of its potable life in his charge (unboiled) will vary as to whether he adopts a system like that employed in treatment (3) or leaves it in an ordinary room with a temperature of 90°—95° Fah. or in a hot godown with a temperature well over 100° Fah.

The results of these experiments are :—

(1) The keeping quality of milk, *i.e.*, its capacity to remain in the same state as when milked will vary with (*a*) the conditions of milking, (*b*) the system adopted to check bacterial development, (*c*) the air temperature and milk temperature to which it is exposed.

(2) The system of treatment to ensure quality at delivery will vary with (*a*) the length of the journey in time, (*b*) the temperature of the day, (*c*) the original conditions under which milking took place.

II. *Transport of milk.*

This series was undertaken to examine the conditions and causes of butter formation, frequently found, in particular in buffalo milk, after transport, and to arrive at some means of prevention. The last experiment of the series combined as far as possible the findings of this section with those of the first on keeping quality.

The means and length of transport were the same in all experiments of this series which numbered about eight. A country cart was sent about 6 miles, taking 1 hour 50 minutes to 2 hours on the journey. This distance and means of transport by cart were taken as probably representing the likely effect in oscillation and time taken by a motor lorry fitted with solid rubber tyres and travelling 12—15 miles per hour on local roads. Without going into the details of each of the earlier experiments of the series the conditions may be briefly stated as follows :—

(*a*) *Milks issued* (1) whole buffalo milk, (2) buffalo milk diluted with skim milk so as to contain a fat percentage equal to that in average cows' milk, (3) whole cows' milk.

(*b*) *Quantity in churn* (1) full churn, (2) churns half full, of same milk types.

(*c*) *Temperature* (1) untreated arriving at customers or town depôt at from 92°—105°. (2) Chilled to 40° and kept cool by jacket arrangement arriving at customers at from 80°—84°.

(*d*) *Time* (1) arriving at customers or city depôt at about 3—3½ hours after milking, (2) arriving at customers about 5—6 hours after milking.

In the experiments undertaken, the conditions mentioned above were combined in every possible manner. The results of the earlier experiments may be stated briefly as follows :—

(1) Butter was formed under certain conditions on all types of milk used. Whole buffalo milk produced on an average about 3 times the weight of butter found on cows' milk though at times the difference was slightly less. The butter in the latter was invariably in a finer grained state. There was generally less butter formed on the diluted buffalo milk than in the whole milk but always considerably more in the diluted buffalo milk than was found in corresponding cows' milk. Indeed when the reduced proportion of fat in the buffalo milk is considered, the proportion of fat appearing as butter was quite as high as that in the whole milk. Dilution appeared thus to have little direct effect in restraining the rise and formation of butter.

(2) The weight of butter found on the half churn of milk was invariably greater than in the full churns, with similar types of milk under similar conditions of temperature and time.

(3) The weight of butter on milk chilled by ice and delivered at 80°—84° was always considerably greater than on the untreated where type, time and quantity were the same. In fact butter was invariably present in every case of cooled milk. In untreated milks the butter found was variable in amount and character. In buffalo milk it was usually present in solid form though in less quantity than in cooled milk, whether whole or diluted, when the temperature of the milk was 92°—95°. Above this it was visible as oil drops. Cows' milk delivered at the temperatures mentioned was clear of butter. Below 90° butter indications appeared.

(4) There was a slightly greater tendency to increased butter in samples arriving late after milking.

(5) Warming the milk in which butter was evident after receipt caused a disappearance of butter, that of cows' milk melting first. Above 120° all solid fat disappeared. On cooling, when the original amount of butter was small, the process of warming appeared to result in entire reabsorption of the fat, otherwise the butter appears as oil on the milk surface ; being more visible on that of cows than in buffaloes on account of the yellow colour of the former fat.

Summarized. The worst transporting sample was a half churn of whole buffalo milk chilled, travelling at 70°—80° and arriving some 6 hours after milking.

The best travelling sample of buffalo milk was a full churn of milk, untreated, delivered with a milk temperature of 105° some $3\frac{1}{2}$ hours after milking.

Cows' milk chilled invariably had butter, and, if untreated, was virtually free of it.

During the series of tests mixed samples of buffalo and cows' milk were usually employed. It happened however that in several duplicating cases the milk of single animal was employed. Both among buffaloes and cows these "single animal" butter products were found to vary in quantity very considerably from the average. This fact coupled with the fact that buffalo milk diluted to the fat percentage of cows showed a greater weight of butter (not much short of that in whole buffalo milk), than that derived from cows' milk, led to the possible conclusion that the greater total fat percentage in the buffaloes' milk was not the real cause of the greater tendency to form butter on transport.

It was decided therefore to examine the individual milks of the dairy buffaloes and cows, these animals being in the middle of lactation and presumably normal, and the effect of transport on these. The type of transport remained the same. All samples however were issued in half bottles, chilled and cooled, and sent out to arrive 5—6 hours after milking, which the earlier experiments

had shown to be most conducive to butter formation. Samples of all milks used in the several comparative transport tests were placed aside in creamometers maintained at 60° Fah., and the comparative rise in cream noted. The fat percentage in the milks was taken in the Gerber and an examination of the fat globules of each individual milk made under the microscope.

The following table gives the average results of several tests thus made. Though the quantities of fat varied slightly on different days the animals in this respect and in the rate of cream rise maintained the same order.

BUFFALOES.

	Average of creamometer at				Average percentage	Average weight of butter, grams per ½ pint
	11 A.M.	5 P.M.	6 A.M.	6 P.M.		
(1) Ledi ...	2·5	3·3	7·5	9·5	8·3	1·63
(2) Dhundy ...	6·0	10·27	12·0	12·6	5·8	3·93
(3) Bhurey ...	3·75	6·3	11·8	12·5	9·6	3·09
(4) Chandry ...	3·2	4·8	9·0	9·5	7·0	2·36
(5) Heera ...	2·5	5·8	10·0	11·0	8·4	3·6
			COWS.			
	11 A.M.	5 P.M.	6 A.M.	6 P.M.	Fat %	Butter weight.
(1) Sakhoo ...	3·23	5·8	6·7	7·0	3·3	0·69
(2) Harni ...	2·3	3·6	5·4	2·4	2·9	0·96
(3) Ganga ...	1·9	3·9	8·9	10·0	4·6	0·98
(4) Narbada ...	2·5	5·4	9·3	11·0	5·2	1·23
(5) Mathura ...	2·1	3·1	7·5	9·5	5·8	1·13
(6) Tulga ...	2·0	2·8	5·8	9·0	4·2	0·53

These figures show that there is a greater tendency to form butter on transport in buffalo milk than in cows. Though this may have something to do with greater quantity of fat present, it is by no means in proportion to the total fats in the milk—compare among buffaloes Dhundy and Ledi and cows Tulga with Harni and Ganga.

There appears to be a fairly close relation between the butter formed and the rate of rise of cream. The butter weights among the 5 buffaloes used in the experiment take the order 2, 5, 3, 4, 1 and the creamometer readings at 5 P.M. take the order 2, 3, 5, 4, 1. Examined under the microscope the fat globules were found to vary very considerably in size and in the percentage of the different

sizes contained in the milk of each animal. The writers were not in a position to make any accurate counts of the sizes and their number found in each sample. Mr. Graham who kindly made the microscopic examination, dealing with samples simply by name and without knowledge as to whether the sample was from a cow or buffalo, placed Ledi with the cows because of the high percentage of the smallest globules.

If the fat globules were divided into (1) large, (2) large medium, (3) medium, (4) small medium, and (5) small :—

Bhurey had the largest number of group 1 but also a large number of group 3.

Dhundy had distinctly the highest percentage of those classed as large medium.

Heera had good percentage of this size with group 3 prominent.

Chandry chiefly number three.

Ledi numbers 3 and 4 and a fair number of even number 5.

The variation in the size of the fat globules has a distinct and recognized effect on the rate of rise of the cream, and it is concluded that the tendency to coagulate to butter on transport is related to the size of the globules of fat in the milk and that the greater number of those of larger size in the milk of buffaloes compared with cows accounts for the more extensive formation of butter in the former, and in the milk of some buffaloes compared with others. Judged by earlier experiments the lower melting point of cow fat or that of one individual animal compared with another may be an acting cause.

Turning to the cows' milk, variation from the above is greater. Taking cows 4, 3, 2, 6 (*see* p. 337) it will be seen that their butter formation and cream rate of rise conform. On the other hand, in the cases of Mathura and Sakhoo the butter formation shows no connection with the rise of the cream but is in closer connection to the total fat percentage.

When examined under the microscope

Harni had a certain number of fat globules of the size large medium but the majority were small medium.

Tulga a few medium but the majority were small.

Ganga and Narbada were somewhat alike, small medium and small though the latter appeared to have rather more of small medium and medium.

Mathura was more like Ganga.

Sakhoo held some considerable number of medium.

The microscopic results tend on the whole to follow the creamometer returns. They do not explain the fact that a rapid rise of cream in Sakhoo's milk does not coincide with a big butter formation, or that a slow rise in Mathura's milk gives almost the same amount of butter as was found in Narbada's milk. Difference in melting points or in amounts of other milk constituents in solution may eventually account for these and are under examination. The general showing of this experiment, when taken into consideration with the difference of butter formation in buffalo milk, diluted to the fat percentage of cows, and whole cows' milk, is that the tendency to form butter on transport is related to the rate of rise of cream and dependent on the percentage of the number of larger fat globules present.

The last experiment of this series was framed to test the general indication of earlier experiments which pointed to the fact that to overcome the butter formation difficulty in long and specially rough transport, *heating*, not cooling of the milk was necessary at the issuing extra city centre ; and to study this action in relation to keeping quality.

In these tests ½ churns of whole buffalo milk were issued so as to arrive 5—6 hours after milking, as this was most conducive to butter formation. Four churns were issued two of which were heated to 140° for 10 minutes, one issued untreated, and one chilled to 40° and kept cool by the jacket method, mentioned earlier. The acidity of all samples was taken at milking, on return to the dairy (now the town depôt) and again at 6 P.M., and 6 A.M. the following morning. The temperature on arrival of the two heated samples was 110°, that of the untreated 105° and that of the chilled sample 80°. On arrival after transport the pasteurized samples were devoid of any traces of butter, the untreated one showed oil drops on the surface, the chilled one the usual large butter accumulation. On

return to the dairy one of the two pasteurized samples was cooled to 60°Fah. and then placed with the other three, thus giving 4 conditions between 12 noon and 6 P.M.

(1) Pasteurized, (2) Chilled and kept cool, (3) Untreated, (4) Pasteurized and cooled on receipt after transport.

The acid developments over those taken at milking, read by 6 P.M. 0·25, 0·1, 0·65, and 0·1. Untreated milk was thus sour and definitely unpotable by 6 P.M. Simply pasteurized milk had almost reached the unsaleable condition while Nos. 2 and 4 were practically the same and had only developed 0·1 acidity. Next morning all had become unpotable. In the chilled and cooled milk the curd formed was a pure lactic one, while that pasteurized and subsequently cooled had developed bitter milk.

The practical conclusions gained from this combined series on keeping quality and transport may be stated as follows :—

(1) Care as to the conditions and cleanliness of the milking and of the vessels into which this is made will add several hours to the effective life of the milk and hence the distance over which it may be transported. Sterilization of the vessels apart from mere washing is important.

(2) Given transport by rail and the milking centre and receiving depôt near the same, a system of chilling to 40°Fah. at the milking centre and preservation of the cooled state either by inlet ice holders or by a system of water capillary will tend to render the delivery of this milk in a fit condition possible, even in this country, 10—11 hours after milking. This system of maintaining quality or the simpler but less effective one of chilling to 40° Fah. cannot however be adopted, if transport is by cart or motor lorry over rough roads, without resulting in the formation of butter. This butter formation tendency will probably be apparent in cold weather in untreated buffalo milk.

(3) Under the conditions of road transport the tendency to butter formation in buffalo milk must be considered along with any system for improving the keeping quality.

(4) The tendency to form butter will vary with the following conditions :—

(*i*) The temperature at which the milk is transported, being non-existent above 105°, possible in slight quantity or as oil between 105° and 90°, and certain below this increasing with the coolness. (In this last respect the writers were unable to transport at very low temperature, *i.e.*, below 50° and it is improbable that such temperature could be maintained in the hot weather). As far as our lowest delivery temperature 80° is concerned the above holds.

(*ii*) Degree of fulness of the milk churn, being less if the churn is quite full.

(*iii*) The length of time after milking at which transport is done, the amount of butter being greater in ratio to the increase of time.

(*iv*) The kind of milk transported, butter being found in all milks below 90°, but more so in buffalo's than cow's, and in the milk of one individual more than in another. The writers believe this to be principally associated with the size of the predominant fat globules in the milk rather than with the total fat contained, though differences in melting points and in the quantities of other solids in solution may affect results. The creamometer may be used to indicate whether milk will form more or less butter on transport, but is not infallible.

(5) The best treatment for all road-carried milk over any distance and indeed the only treatment for buffalo milk below 90°Fah. is pasteurization at the milking centre to 140°—160° before issue, dependent on time of transport and temperature, and its subsequent chilling on receipt at the city depôt before retail issue. This will not only prevent the fat from forming butter but will allow of a good quality milk of acidity equal to that at milking 6 to 8 hours after milking and to some extent will prevent the harmful effects produced on this

quality by inferior milking conditions, though the writers desire to point out that they do not wish to indicate that the advantage of this method should be used in place of care and cleanliness or to hide the absence of either.

(6) This method would not be difficult to adopt. It is in their opinion essential that any rural milking centre to allow of a proper washing and sterilizing of churns and milking vessels should be fitted with a steam boiler, steam jet, sterilizer and steam-fed washing tanks, as unless steam is freely available—washing and sterilization are bound to be inadequate and cleansing nominal as far as bacteria are concerned. An addition of a pasteurizer to this outfit would only be a matter of Rs. 180 to Rs. 250 according to size.

The cooling plant could be maintained at the city depôt without any great initial or recurring cost as it would probably be near an ice making plant. As there is always a ready sale for ice, an ice making and chilling plant would probably pay for the chilling requirements of the dairy by the price received for ice sold.

A plant for the rural issuing centre could be had for about Rs. 900 including boiler, steam jets, steam-fed tanks, and pasteurizer but excluding a sterilizer which might cost an additional Rs. 300 to Rs. 400. An expenditure of Rs. 220 would supply a milk cooling plant if ice was locally contracted for. A capital expenditure of Rs. 2,500—3,300 should put the depôt in possession of its own ice making and chilling plant.

(7) Keeping quality and the tendency to form butter on transport need offer no difficulties to the establishment of rural dairy centres dealing principally in buffalo milk outside big cities. A comparatively small additional outlay of capital over and above that required for cleaning and sterilizing on a large scale (together with care as to the conditions of milking) will suffice.

AMERICAN COTTON IN THE PUNJAB.

BY

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TWELVE years ago there was practically no American cotton in the Punjab, except a few plots at Hissar and Lyallpur Government Farms. Even as late as 1911 the area was well under 10,000 acres. Last year the area under this cotton was, at a conservative estimate, 70,000 acres, and the area this year (1915) is probably still higher. It is estimated that in 1914 the area under American cotton in Jhang was 35,000 acres, in Lyallpur 22,000 acres and Gujranwala 3,000 acres, *i.e.*, a total of 60,000 acres on the Lower Chenab Canal. The remaining 10,000 acres were grown at Sargodha on the Lower Jhelum Canal and in various other tracts in small quantity, *e.g.*, Montgomery on the Lower Bari Doab Canal.

From the experience of a number of years it may be confidently asserted that the yield of American cotton is on the average better than that of *desi*. *Zemindars* generally admit this, though of course there are certain disadvantages in connection with its growth which will be dealt with later. A premium of at least Rs. 1-8 a maund over *desi* cotton can be obtained now and taking the average yield at 6 mds. we have an extra profit per annum for the *zemindars* of $70{,}000 \times 6 \times 1\frac{1}{2} =$ Rs. 6,30,000.

In 1914 *desi* cotton was selling early in the season at Rs. 3-12 a maund whereas American fetched Rs. 5-8 to Rs. 6-8 a maund. There was a large consignment at Lyallpur in February for which Rs. 7-8 per maund of *kapas* had been paid. It is only natural, therefore, to expect, as is indeed the case, a large increase in the proportion of

American as regards *desi* cotton in Canal areas this year, even though the total area under cotton be much reduced.

The history of the successful introduction of this cotton in the Punjab Colonies is instructive. The first attempt to grow American cotton occurred about 1884 when some Upland Georgian seed was distributed by the office of the Director of Land Records. Apparently the crop grew fairly well and became common in the form of stray plants among *desi* cotton for many years afterwards (*see* remarks in the Annual Report of the Agricultural Department, Punjab, for 1904, para. 7). In 1902 the question of American cotton came into prominence again, owing to the tests made by Mr. Mollison, late Inspector-General of Agriculture, in Hissar. In his note on the improvement of Indian cotton, 1902-03, he remarks "27 newly introduced and 5 acclimatized American Uplands did surprisingly well at Hissar on deep rich alluvial soil helped by irrigation. All exotics there, came to maturity, on an average, as soon as the early ripening indigenous varieties. They did not therefore suffer from frost."

In the following year 1903, the matter was taken up and trials were made at the Lyallpur Farm with Cawnpore acclimatized American and 'Punjab Narma'. The seed of the latter was obtained with difficulty through the courtesy of Messrs. Mela Ram & Sons of Lahore, who managed to collect sufficient seed for half an acre from stray plants growing among *desi* cotton. This 'Punjab Narma'[1] was a relict of the Upland Georgian first grown here 20 years previously and still found all over the central part of the Province as stray plants in *desi* cottons. It was unknown as a separate crop, though in favour with the housewife on account of its softness. Curiously enough some seed of Khaki American cotton appears to have been given out at the time of the Boer war and Khaki coloured American can be had now all over the Canal Colonies in minute quantities or as stray plants in *desi* cotton—it is exclusively used for home consumption by *zemindars*. One never sees more than about one-twentieth acre of it alone.

[1] Narma—Soft.

Both in 1902 at Hissar and in 1903 at Lyallpur the sowings were late and the late pickings in December were affected by frost. In 1904 Mr. Mollison supplied trained men and bullocks together with drills for the proper sowing and trial of a few American and some good Bombay *desi* types, with *zemindars* at Lyallpur. The early drilled seed did not germinate and had to be re-sown. Some of the *desi* types failed but in spite of poor germination the American cotton, especially 'Punjab Narma,' 'Dharwar acclimatized' and 'Cawnpore acclimatized' gave encouraging results. It had now become obvious that American cotton, to be successful, must be sown early, *i.e.*, if possible before the 20th April. It was also apparent from this year's trials that 'Dharwar acclimatized' had better staple and matured earlier than 'Punjab Narma' while it yielded better than 'Cawnpore acclimatized.' Further trials confirmed this. In 1905 the trials were extended to Sargodha on the Lower Jhelum Canal. Altogether about 300 acres more or less were grown from Dharwar seed in 1905.

Up to this time growers of American cotton secured in many cases extra water and compensation in case of failure of the crop. The extra water was demanded as it was asserted American cotton required much more water than *desi*. This is wrong ; though as American is somewhat later than *desi* an extra watering is sometimes necessary in October.

It was after 1905 that it became possible to work systematically. The Agricultural Department here may be said to have properly started in that year. Sales for American cotton were started in Sargodha in 1905-06 and in Lyallpur in 1907 and premiums of over Re. 1 a maund over *desi* cotton were generally obtained at these sales. The importance of the Botanical aspect of the question was soon recognized. Dharwar American cotton is apparently very mixed. It was noticed that the smooth leaved types suffered from Jassids which attacked the leaves and caused them to crumple up and become reddish in colour. These attacks were, however, not regular and were almost completely absent in some years. The Botanical work including a large number of selections and crosses was transferred to the Botanical Section in 1908. Although by this time the cultivation of American cotton was gradually spreading, a good deal of doubt

was constantly expressed as to the success of this cotton in the Punjab. Some time after 1909 an experienced member of the firm of Messrs. Ralli Brothers informed the writer that American cotton would never succeed and that there was no demand for it; last January this firm paid a premium of Rs. 2-9 a maund of *kapas* for American, in one of our sales.

In 1909, two varieties were handed over from the Botanical Section—*viz.*, a 'Punjab Narma' and a 'Dharwar American' which did not appear to be any improvement over the ordinary crop. In 1910, No. 3-F and No. 4-F were handed over—both proved heavy yielders. The former being early was selected for distribution in 1912 and 1913. In the latter year trouble with Jassids occurred again and this cotton being smooth leaved was abandoned. It may be noted in passing that American cotton grown from Dharwar seed suffered still more but luckily the attack was confined to a comparatively small tract and the spread in the cultivation of American cotton was not seriously affected. 4-F was not affected though 100 acres of it was growing with *zemindars*, in many cases the fields being alongside those of 3-F. In 1914, over 2,000 acres of 4-F were grown and in the present year over 72,000 ℔. of seed has been sold in Lyallpur at Rs. 3-12 a maund, the price of bazaar seed being Rs. 2-8. In addition to the above many *zemindars* kept their own seed. Various influential men and some Co-operative Banks acted as agents for the sale of the seed—a commission of 8 annas a maund being paid for this. Last year sales of *kapas* were held at four separate centres, two being held in Sargodha by the Deputy Director. A premium of over Rs. 2 a maund was obtained in all cases—at Lyallpur premiums of Rs. 2-13 and Rs. 2-9 were obtained.

A distinct step in organization was made in 1911 when the policy of the Department as regards cotton was for the first time laid down as the result of a discussion in Committee. In 1913, the District work at Lyallpur was put in charge of the Professor of Agriculture.

The Department has prepared and distributed large numbers of leaflets in the Vernacular giving careful details as to cultivation, watering, etc., and work in this direction has met with much more success than could have been reasonably expected. A good deal of

the success attained is due also to the large number of visitors who come to the Farm every year.

The cultivation of American cotton at first spread slowly in the Colony; the most notable progress occurred in Jhang which has only comparatively recently been extensively irrigated. Forty per cent. of the cotton in Jhang is now estimated to be American—in many villages nothing but the latter is grown.

A large portion of the American cotton marketed there is said by exporters to contain 25 to 30 per cent. *desi* cotton. This is not apparent in the fields except in rare cases. In the opinion of the present writer where heavy mixing occurs, it is due (1) to middlemen, through whose hands the cotton must at present pass, and (2) to admixture of types of American, some being of shorter fibre than the main crop and confused by exporters for *desi*. The latter is a common mistake. One grower of 4-F variety there who sold his *kapas* independently claimed that he not only got a much better price for it than for his other Americans but it improved the price of all of his American cotton last year.

In Lyallpur the greater quantity is grown in tracts round the Farm and Samundri Tehsil. During the present season a fair amount of American cotton will be grown in the new Lower Bari Doab Colony in Montgomery. One grower has already sown over 300 acres.

There is no doubt that the critical period for American cotton here is over; the plant has established itself by a sort of natural selection—unsuitable types having been largely eliminated by Jassids and other pests. The efforts of the Agricultural Department in enlisting the support and co-operation of local ginners and of exporters who have done a good deal in issuing pure seed and in securing good prices at the auctions has helped. The prices obtained at the auctions, though the latter have actually only controlled a small percentage of *kapas*, has fixed the premium each year and for the last 3 years, individual *zemindars* have always been able to obtain a good premium in the open market. One of the great difficulties is the mixing with *desi* that occurs—this is in the opinion of the writer largely the fault of ginners and in some

cases of spinners—one such case occurred here in April when a Bombay spinner ordered mixed American and *desi* cotton (lint). Such practices unfortunately re-act ultimately on the *zemindar*. As an instance of the advantage of co-operative selling the case may be noted of one big buyer who informed the writer with glee that he had bought fine quality American cotton at Rs. 1-4 a maund less than he had paid in our sale that very day at Gojra. Sales will therefore be necessary for some time to come.

PUMPING INSTALLATIONS IN THE WESTERN CIRCLE OF THE UNITED PROVINCES.

BY

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In the Season and Crop Report of the United Provinces of Agra and Oudh for the year 1913-14, the following figures are given :—

Total cropped area	... ...	38,768,504 acres.
Area irrigated during the year from—		
1. Government canals	... ...	2,657,594 acres.
2. Wells	... ...	7,000,118 ,,
3. Other sources	... ...	1,886,523 ,,
	Total ...	11,544,235 acres.

Thus almost one-third of the cultivated area of the Province is irrigated. The figures for some of the western districts are very high, *e.g.* :—

	Government canals	Wells	Other sources	Total irrigated	Net cropped area
Meerut	329,236	231,853	5,865	566,954	1,001,724 acres.
Bulandshahr ...	211,634	236,540	9,899	458,073	791,947 ,,
Aligarh	166,731	317,861	7,443	492,035	830,392 ,,

In the three districts given above it will be seen that more than 57 per cent. of the total cropped area is irrigated. This vast amount of irrigation opens up opportunities for the trial of various kinds of water-lifting appliances. Before the appointment of the Agricultural Engineer experimental work of this nature was entirely in the hands of the Deputy Directors. Some progress was made and at least one suitable type of installation resulted. In the Western Circle

there are very large tracts of country in which wells giving a discharge of 8,000 to 20,000 gallons per hour are numerous. These wells are made by sinking a masonry cylinder on to a clay layer or "mota." A hole bored through the clay allows the water from below to rise in the cylinder to percolation level. The distance from ground level to percolation level in the wells under consideration is between 20 and 30 feet. The clay layer is, as a rule, about 40—50 feet below ground level, so there is generally between 10 and 20 feet of water in the well. The ordinary way of raising water in these tracts is by bullocks and leather buckets. On the large wells 6 to 8 buckets worked by 12 to 16 pairs of bullocks are to be seen.

Our early experiments showed that under these conditions water can be raised much cheaper by an oil engine and centrifugal pump than by bullocks.

Demonstrations were given and *zemindars* and cultivators soon began to realize the economic advantage of this class of installation and a big demand quickly arose. The experimental stage was only completed about a year ago and since then thirty-five sets have been dealt with. There appears to be no reason why during the next few years hundreds should not be put down. The plant consists of a $4\frac{1}{2}$ or 7 B. H. P. oil engine and a 3″ or 4″ centrifugal pump. The engines are made by Turners, Ipswich, England, and are imported direct by us. The pumps are made by the Pulsometer Centrifugal Co., and by Tangyes and are bought through Burn & Co., and Jessops, respectively. The engine is put on the top of the well and the pump just above the water level in the well. The drive is either direct from engine to pump or through a piece of shafting. The engine also drives in some cases cotton gins, chaff cutters, etc., when it is not required to work the pump. The installations cost from Rs. 1,400 to Rs. 1,800 according to their size.

One year's experience has shown the work to be a success and there now remains nothing but the rapid development of the organization for erecting and keeping the machinery in repair. The progress in the future should be rapid. During the first year we have trained a staff of supervising *mistries* and a large staff of drivers. A school for turning out drivers has now been organized. Ordinary

village youths are taken, preferably sons or dependents of men who have put down, or propose to put down, oil engines and two months' training makes them into efficient drivers. Only one type of engine is being put down. This makes it easier to train the drivers. The demand at present is greater than we can cope with efficiently and it has now really got large enough to interest commercial firms. Turners have promised to send out a man shortly to take up the matter from the commercial point of view and see what can be done in the way of establishing agencies to deal with the work. It is of interest to note that these oil engines are not being installed merely by the large and wealthy landowners. They are being put down, in the majority of cases, by cultivators and small *zemindars* who take a loan or *takavi* from Government. Government is granting *takavi* readily for the purpose and in one division alone of the Western Circle half-a-lakh of rupees will be available this year. The work in hand has opened up several other lines of investigation along which enquiries are being pursued. Small engines of $2\frac{1}{2}$ B. H. P. are now being tried and it is expected these will also prove economical and catch on with the smaller cultivators. Also as regards wells an interesting piece of work is going on to see to what extent the masonry cylinder which is so costly an item in construction can be done away with where a man proposes to make a new well on which a pumping plant is to be used. It seems very probable that the cost of the well can be reduced by several hundreds of rupees, which would go a long way in buying the oil engine and pump. Installations suitable for deeper wells are also occupying some attention and a portable set is being got together, which, it is hoped, will prove suitable for the various members of small village Co-operative Credit Societies.

These pumping installations confer a direct benefit on the community. It is hoped that many will be indirectly of great help to the Agricultural Department resulting in the organization of seed farms and depôts and centres of distribution of seed. For example as regards cotton, each of these engines will command about 50 acres of the crop under one or more cultivators. This will be sown with departmental seed and the next year enough good seed will be available to sow 1,000 acres. In a district growing a lakh of acres of cotton a chain of 20

such selected seed farms would enable one to cover the whole district with new seed once every five years. Each selected oil engine would have its cotton gin attached and ginning and distribution of seed would thus be rendered easy. In time we might expect the owners of these seed farms to run without much assistance or supervision from the Agricultural Department. Having gradually established a reputation they would become the recognized seed merchants of their particular tract. In this way the Agricultural Department would gradually be relieved of the burdensome work which at present occupies so much of its time and which in other countries is done by seed merchants. In conclusion the writer would like to express his thanks to Chaudhri Amar Singh, Rai Bahadur, Rais, Pali, District Bulandshahr, without whose enthusiastic assistance and advice much of the success achieved would have been impossible.

THE VITALITY OF SEEDS PASSED BY CATTLE.

BY

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It had been noticed that when whole grains of wheat, etc., were fed to bullocks, a considerable number of these grains passed through the animals in an apparently undigested state. The question then arose whether whole wheat grains fed to these animals working in the wheat fields in the wheat growing season, would pass through the animals, germinate, reproduce themselves and be one cause of the mixtures of types which sometimes occur in pure culture plots. Mixtures in such plots are often very difficult to explain. As it was necessary for the experiment that the whole of the manure from the animals should be used, a season of the year was selected when the bullocks could be left idle during the experiment. Towards the end of January 1915, six of the bullocks, which usually work on the experimental lands at Lyallpur, were made available. They were aged from 8 to 14 years. The animals were tied up in a shed all night, the stalls being so fixed up that the dung from the different bullocks should not mix. During the day the cattle were tied up in the open air so far apart that mixing of dung would not take place. Arrangements were made that the cattle should never be a moment, night or day, without an attendant looking after them.

The experiment started on 21st January 1915 at 6 P.M. and continued till 1st February 1915 at 7-30 A.M. (*see* statements I—XII inclusive printed below). The cattle had been fed previously on crushed gram and maize grains, with fodder composed of green oat-plants and ordinary wheat *bhusa* (chopped wheat straw). From the

evening of 21st January till the evening of 27th January each bullock was given daily at 6 P.M. two seers of whole wheat grains previously soaked for one hour in cold water. Any grains left uneaten by 10 P.M. were removed, air dried to about their original state, weighed, and the weight recorded in column No. 3 of the statements below. The fodder given during the experiment was a mixture of green oat-plants and wheat *bhusa* as shown in column No. 2 of the statements. It was weighed out in the afternoon and fed to the animals throughout the day. Rejected fodder was removed every day about 6 P.M., weighed, and the weight entered in column No. 2 of the statements.

Immediately an animal made dung, the dung was collected into a numbered basket which stood behind that animal. The baskets were cleared every day at 7-30 A.M. and at 6 P.M. The dung cleared from the baskets at 6 P.M., was washed next morning at 8 A.M. All grains were picked out and at once placed for germination in a labelled bed of sterilized sand spread out on the floor of a room, the bed being covered with sterilized flannel. The collection of dung made at 7-30 A.M. was separately and similarly treated the same day.

In the cases of some of the bullocks it was found that bits of broken gram and maize grains came through in the dung up to $1\frac{1}{2}$ days after the experiment started; in other cases similar bits appeared up to $2\frac{1}{2}$ days. A considerable number of wheat grains capable of producing strong plants and of reproducing themselves in the field, appeared in the dung of every bullock within $13\frac{1}{2}$ hours from the start of the experiment (*see* column No. 6 of the statements I—VI inclusive). The smallest number of such wheat grains passed by a single bullock up to that time was 12 (Statement III, column No. 6) and the largest was 865 (*see* statement II). Two days or more after the experiment started the number of such grains passed by a single bullock eating practically all the grains offered up to that time, were from over 1,000 to over 4,000 in a working day approximately (*i.e.*, 7-30 A.M. to 6 P.M.) (Statements II, V, etc.), while the number passed during the twenty-four hours then were up to over 9,000 and from 5,000 to 6,000 were commonly met with.

On the evening of the 28th January and daily until the experiment ended, two seers of gram grains soaked for one hour in cold water

were fed to the bullocks in place of the wheat grains. Otherwise the work was carried on, on the same lines as before. In all cases large numbers of wheat grains capable of reproducing themselves came through the bullocks for about two days after we had ceased to feed them with these grains. The number of undigested wheat grains gradually diminished after that; but a few of these were still passing when the experiment ended on the evening of the 1st February 1915. It is just possible that although no wheat grains were to be seen in the wheat *bhusa* fed to these animals, there may have been a few wheat grains in that; but assuming that the same proportion of wheat grains fed in this accidental way were digested beyond the stage at which they could reproduce themselves, as were so digested in the first seven days of the experiment, then the number in the *bhusa* in the case of several of the bullocks, would have been sufficient to have attracted notice. It seems more likely that most of these grains came from the grain fed to the cattle on or before the 27th, and that they remained in the stomachs of the bullocks longer than the broken bits of maize did at the start of the experiment, simply because these wheat grains were not broken and they therefore resisted the digestive action better.

During the whole experiment as much as 20·5 per cent. of the grains fed to a single bullock passed through him, germinated and produced strong healthy plants while the smallest figure got from a single bullock was 9·6 per cent. (*see* statement XIII, column 5).

As was the case with the wheat grains, gram grains apparently undigested appeared in the dung of all the animals within 13½ hours of the time we commenced to feed the cattle with them; also large numbers of apparently undigested gram grains appeared daily in the dung of all the bullocks; but as statements VII to XII inclusive show, practically none of these gram grains germinated.

From this experiment it is obvious that uncrushed wheat grains fed either intentionally as such, or accidentally in *bhusa*, to cattle working on pure culture wheat plots about sowing time, or fed to these animals less than about a week before they are put to work on such lands, are a serious source of danger to the purity of these crops. In the case of grams there appears to be

comparatively little danger. Incidentally it was also discovered that seeds of

Piazi (*Asphodelus fistulosus*)
Bathu (*Chenopodium album*)
Rawari (*Lathyrus Aphaca*), etc.,

found in the dung from these experiments germinated. It is hoped to take up the cases of barley, maize and other important crops, and weeds as early as bullocks are available.

The amount of obviously undigested material which came through these bullocks was astonishing, and an investigation into the amounts of undigested foods that come through animals when grains are fed in the whole and in the crushed or ground states would no doubt be of value to farmers and others.

STATEMENT I.

Showing the vitality of wheat grains after passing through the stomach of Bullock No. I (age 14 years approx.).

1	2				3				4		5	6
Date of feeding	Fodder: Particulars	Fodder: Total weight given, in seers	Fodder: Hours of feeding	Fodder: Weight not eaten, in seers	Wheat grain: Weight of unsoaked grain fed, in seers	Wheat grain: Period of soakage before feeding	Wheat grain: Hours of feeding	Wheat grain: Weight of air dry grain not eaten, in seers	Dung collection: Date	Dung collection: Hour	Date of washing grains out of dung and of sowing them	Number of grains which produced strong healthy plants
21-1-15	Green oats ... 9 seers *Bhusa* ... 6 ,,	15	Throughout the day.	5	2	1 hour	6 P.M.	*Nil*	22-1-15	7-30 A.M.	22-1-15	363
22-1-15	Green oats ... 18 ,, *Bhusa* ... 4 ,,	22		4	2	Do.	Do.	*Nil*	22-1-15 23-1-15	6 P.M. 7-30 A.M.	23-1-15	1,172 3,554
23-1-15	Do.	22		*Nil*	2	Do.	Do.	2	23-1-15 24-1-15	6 P.M. 7-30 A.M	24-1-15	2,314 4,678
24-1-15	Do.	22		*Nil*	2	Do.	Do.	2	24-1-15 25-1-15	6 P.M. 7-30 A.M.	25-1-15	917 840
25-1-15	Green oats ... 20 seers *Bhusa* ... 4 ,,	24		*Nil*	2	Do.	Do.	1	25-1-15 26-1-15	6 P.M. 7-30 A.M.	26-1-15	153 120
26-1-15	Do.	24		*Nil*	2	Do.	Do.	$1\frac{7}{8}$	26-1-15 27-1-15	6 P.M. 7-30 A.M.	27-1-15	508 305
27-1-15	Do.	24		*Nil*	2	Do.	Do.	2	27-1-15 28-1-15	6 P.M. 7-30 A.M.	28-1-15	309 734

NOTE.—There were almost 22,800 unsoaked wheat grains in one seer weight.

STATEMENT II.

Showing the vitality of wheat grains after passing through the stomach of Bullock No. II (age 13 years approx.).

1	2				3				4		5	6
Date of feeding	FODDER				WHEAT GRAIN				DUNG COLLECTION		Date of washing grains out of dung and of sowing them	Number of grains which produced strong healthy plants
	Particulars	Total weight given, in seers	Hours of feeding	Weight not eaten, in seers	Weight of unsoaked grain fed, in seers	Period of soakage before feeding	Hours of feeding	Weight of air dry grain not eaten, in seers	Date	Hour		
21-1-15	Green oats ... 9 seers *Bhusa* ... 6 ,,	15	Throughout the day.	5	2	1 hour	6 P.M.	*Nil*	22-1-15	7-30 A.M	22-1-15	865
22-1-15	Green oats .. 18 ,, *Bhusa* ... 4 ,,	22		4	2	Do.	Do.	*Nil*	22-1-15 23-1-15	6 P.M. 7-30 A.M.	23-1-15	308 2,690
23-1-15	Do.	22		*Nil*	2	Do.	Do.	*Nil*	23-1-15 24-1-15	6 P.M. 7-30 A.M.	24-1-15	2,235 3,025
24-1-15	Do.	22		*Nil*	2	Do.	Do.	$\frac{1}{2}$	24-1-15 25-1-15	6 P.M. 7-30 A.M.	25-1-15	1,307 4,158
25-1-15	Green oats ... 20 seers *Bhusa* ... 4 ,,	24		*Nil*	2	Do.	Do.	$\frac{1}{4}$	25-1-15 26-1-15	6 P.M. 7-30 A.M.	26-1-15	2,870 3,272
26-1-15	Do.	24		*Nil*	2	Do.	Do.	*Nil*	26-1-15 27-1-15	6 P.M. 7-30 A.M.	27-1-15	2,281 2,475
27-1-15	Do.	24		*Nil*	2	Do.	Do.	*Nil*	27-1-15 28-1-15	6 P.M. 7-30 A.M.	28-1-15	4,269 3,281

STATEMENT III.

Showing the vitality of wheat grains after passing through the stomach of Bullock No. III (age over 14 years).

1	2				3				4		5	6
	FODDER				WHEAT GRAIN				DUNG COLLECTION			
Date of feeding	Particulars	Total weight given, in seers	Hours of feeding	Weight not eaten, in seers	Weight of unsoaked grain fed, in seers	Period of soakage before feeding	Hours of feeding	Weight of air dry grain not eaten, in seers	Date	Hour	Date of washing grains out of dung and of sowing them	Number of grains which produced strong healthy plants
21-1-15	Green oats ... 9 seers. *Bhusa* . ,,	15	Throughout the day.	5	2	1 hour	6 P.M.	*Nil*	22-1-15	7-30 A.M.	22-1-15	12
22-1-15	Green oats ... 18 ,, *Bhusa* ... 4 ,,	22		10	2	Do.	Do.	2	22-1-15 23-1-15	6 P.M. 7-30 A.M.	23-1-15	229 1,733
23-1-15	Do.	22		*Nil*	2	Do.	Do.	2	23-1-15 24-1-15	6 P.M. 7-30 A.M.	24-1-15	1,267 1,440
24-1-15	Do.	22		*Nil*	2	Do.	Do.	2	24-1-15 25-1-15	6 P.M. 7-30 A.M.	25-1-15	95 63
25-1-15	Green oats ... 20 seers *Bhusa* ... 4 ,,	24		*Nil*	2	Do.	Do.	1½	25-1-15 26-1-15	6 P.M. 7-30 A.M.	26-1-15	49 59
26-1-15	Do.	24		*Nil*	2	Do.	Do.	2	26-1-15 27-1-15	6 P.M. 7-30 A.M.	27-1-15	26 61
27-1-15	Do.	24		*Nil*	2	Do.	Do.	2	27-1-15 28-1-15	6 P.M. 7-30 A.M.	28-1-15	58 52

STATEMENT IV.

Showing the vitality of wheat grains after passing through the stomach of Bullock No. IV (age 11 years approx.).

1	2				3				4		5	6
	FODDER				WHEAT GRAIN				DUNG COLLECTION			
Date of feeding	Particulars	Total weight given, in seers	Hours of feeding	Weight not eaten, in seers	Weight of unsoaked grain fed, in seers	Period of soakage before feeding	Hours of feeding	Weight of air dry grain not eaten, in seers	Date	Hour	Date of washing grains out of dung and of sowing them	Number of grains which produced strong healthy plants
21-1-15	Green oats ... 9 seers *Bhusa* ... 6 ,,	15	Throughout the day.	3	2	1 hour	6 P.M.	*Nil*	22-1-15	7-30 A.M.	22-1-15	255
22-1-15	Green oats ... 18 ,, *Bhusa* ... 4 ,,	22		6	2	Do.	Do.	*Nil*	22-1-15 23-1-15	6 P.M. 7-30 A.M.	23-1-15	456 2,722
23-1-15	Do.	22		*Nil*	2	Do.	Do.	2	23-1-15 24-1-15	6 P.M. 7-30 A.M.	24-1-15	882 2,351
24-1-15	Do.	22		*Nil*	2	Do.	Do.	2	24-1-15 25-1-15	6 P.M. 7-30 A.M.	25-1-15	338 683
25-1-15	Green oats ... 20 seers *Bhusa* ... 4 ,,	24		*Nil*	2	Do	Do.	*Nil*	25-1-15 26-1-15	6 P.M. 7-30 A.M.	26-1-15	104 176
26-1-15	Do.	24		*Nil*	2	Do.	Do.	*Nil*	26-1-15 27-1-15	6 P.M. 7-30 A.M.	27-1-15	1,627 4,260
27-1-15	Do.	24		*Nil*	2	Do.	Do.	*Nil*	27-1-15 28-1-15	6 P.M. 7-30 A.M.	28-1-15	1,242 2,960

STATEMENT V.

Showing the vitality of wheat grains after passing through the stomach of Bullock No. V (age 8 years).

1	2				3				4		5	6
	FODDER				WHEAT GRAINS				DUNG COLLECTION			
Date of feeding	Particulars	Total weight given, in seers	Hours of feeding	Weight not eaten, in seers	Weight of unsoaked grain fed, in seers	Period of soakage before feeding	Hours of feeding	Weight of air dry grain not eaten, in seers	Date	Hour	Date of washing grains out of dung and of sowing them	Number of grains which produced strong healthy plants
21-1-15	Green oats ... 9 seers* *Bhusa* ... 6 ,,	15	Throughout the day.	3	2	1 hour.	6 P.M.	*Nil.*	22-1-15	7-30 A.M.	22-1-15	15
22-1-15	Green oats ... 18 ,, *Bhusa* ... 4 ,,	22		8	2	Do.	Do.	*Nil.*	22-1-15 23-1-15	6 P.M. 7-30 A.M.	23-1-15	98 101
23-1-15	Do.	22		*Nil.*	2	Do.	Do.	*Nil.*	23-1-15 24-1-15	6 P.M. 7-30 A.M.	24-1-15	1,341 1,777
24-1-15	Do.	22		*Nil.*	2	Do.	Do.	$\frac{1}{8}$	24-1-15 25-1-15	6 P.M. 7-30 A.M.	25-1-15	1,239 2,179
25-1-15	Green oats ... 20 seers *Bhusa* ... 4 ,,	24		*Nil.*	2	Do.	Do.	$\frac{1}{4}$	25-1-15 26-1-15	6 P.M. 7-30 A.M.	26-1-15	2,003 2,614
26-1-15	Do.	24		*Nil.*	2	Do.	Do.	*Nil.*	26-1-15 27-1-15	6 P.M. 7-30 A.M.	27-1-15	2,096 4,989
27-1-15	Do.	24		*Nil.*	2	Do.	Do.	*Nil.*	27-1-15 28-1-15	6 P.M. 7-30 A.M.	28-1-15	4,329 5,419

Statement VI.

Showing the vitality of wheat grains after passing through the stomach of Bullock No. VI (age 8 years).

1	2				3				4		5	6
	Fodder				Wheat grains				Dung collection			
Date of feeding	Particulars	Total weight given, in seers	Hours of feeding	Weight not eaten, in seers	Weight of unsoaked grain fed, in seers	Period of soakage before feeding	Hours of feeding	Weight of air dry grain not eaten, in seers	Date	Hour	Date of washing grains out of dung and of sowing them	Number of grains which produced strong healthy plants
21-1-15	Green oats .. 9 seers *Bhusa* ... 6 ,,	15	Throughout the day.	2	2	1 hour	6 P.M.	*Nil.*	22-1-15	7-30 A.M.	22-1-15	353
22-1-15	Green oats ... 18 seers *Bhusa* ... 4 ,,	22		4	2	Do.	Do.	*Nil.*	22-1-15 23-1-15	6 P.M. 7-30 A.M.	23-1-15	685 4,845
23-1-15	Do.	22		*Nil.*	2	Do.	Do.	*Nil.*	23-1-15 24-1-15	6 P.M. 7-30 A.M.	24-1-15	1,704 4,308
24-1-15	Do.	22		*Nil.*	2	Do.	Do.	$\frac{1}{16}$	24-1-15 25-1-15	6 P.M. 7-30 A.M.	25-1-15	1,293 4,194
25-1-15	Green oats ... 20 seers *Bhusa* ... 4 ,,	24		*Nil.*	2	Do.	Do.	*Nil.*	25-1-15 26-1-15	6 P.M. 7-30 A.M.	26-1-15	2,337 4,846
26-1-15	Dó.	24		*Nil.*	2	Do.	Do.	2	26-1-15 27-1-15	6 P.M. 7-30 A.M.	27-1-15	3,328 8,197
27-1-15	Do.	24		*Nil.*	2	Do.	Do.	*Nil.*	27-1-15 28-1-15	6 P.M. 7-30 A.M.	28-1-15	357 141

STATEMENT VII.

Showing the vitality of gram and wheat grains after passing through the stomach of Bullock No. 1 (age 14 years approx.).*

1	2				3				4		5	6	7
	Fodder				Gram				Dung collection				
Date of feeding	Particulars	Total weight given, in seers	Hours of feeding	Weight not eaten, in seers	Weight of unsoaked grain fed, in seers	Period of soakage before feeding	Hours of feeding	Weight of air dry grain not eaten, in seers	Date	Hour	Date of washing grains out of dung and of sowing them	Number of grams which produced strong healthy plants	Number of wheat grains which germinated and produced strong healthy plants
28-1-15	Green oats 24 seers *Bhusa* 6 ,,	30	Throughout the day.	4	2	hour	P.M.	*Nil*	28-1-15 29-1-15	6 P.M. 7-30 A.M.	29-1-15	*Nil.* *Nil.*	3,148 1,216
29-1-15	Do. ...	30		5	2	Do.	6 P.M.	*Nil.*	29-1-15 30-1-15	6 P.M. 7-30 A.M.	30-1-15	*Nil.* *Nil.*	342 455
30-1-15	Do. ...	30		3	2	Do.	P.M.	*Nil.*	30-1-15 31-1-15	6 P.M. 30 A.M.	31-1-15	*Nil.* *Nil.*	46 24
31-1-15	Do. ...	30		*Nil.*	*Nil.*	...	...	...	31-1-15 1-2-15	6 P.M. 7-30 A.M.	1-2-15	2 *Nil.*	29 24

* The bullock was fed with wheat grains previous to 28-1-15. See Statements I to VI inclusive.

STATEMENT VIII.

Showing the vitality of gram and wheat grains after passing through the stomach of Bullock No. II (age 13 years approx.).*

1	2				3				4		5	6	7
	FODDER				GRAM				DUNG COLLECTION				
Dat of feeding	Particulars	Total weight given, in seers	Hours of feeding	Weight not eaten, in seers	Weight of un-soaked grain fed, in seers	Period of soakage before feeding	Hours of feeding	Weight of air dry grain not eaten, in seers	Date	Hour	Date of washing grains out of dung and of sowing them	Number of grains of gram which produced strong healthy plants	Number of wheat grains which germinated and produced strong healthy plants
28-1-15	Green oats 24 seers. *Bhusa* 6 ,,	30	Throughout the day.	3	2	1 hour.	6 P.M.	*Nil.*	28-1-15 29-1-15	6 P.M. 7-30 A.M.	29-1-15	*Nil.* *Nil.*	5,974 3,972
29-1-15	Do. ...	30		4	2	Do.	Do.	$\frac{1}{16}$	29-1-15 30-1-15	6 P.M. 7-30 A.M.	30-1-15	*Nil.* *Nil.*	344 272
30-1-15	Do. ...	30		$4\frac{1}{2}$	2	Do.	Do.	$\frac{1}{16}$	30-1-15 31-1-15	6 P.M. 7-30 A.M.	31-1-15	*Nil.* *Nil.*	45 14
31-1-15	Do. ...	30		*Nil.*	*Nil.*	...	...	...	31-1-15 1-2-15	6 P.M. 7-30 A.M.	1-2-15	*Nil.* 2	13 39

* The bullock was fed with wheat grains previous to 28-1-15. See Statements **I** to **VI** inclusive.

STATEMENT IX.

Showing the vitality of gram and wheat grains after passing through the stomach of Bullock No. III (age over 14 years).*

1	2				3				4		5	6	7
	FODDER				GRAM				DUNG COLLECTION				
Date of feeding	Particulars	Total weight given, in seers	Hours of feeding	Weight not eaten, in seers	Weight of unsoaked grain fed, in seers	Period of soakage before feeding	Hours of feeding	Weight of air dry grain not eaten, in seers	Date	Hour	Date of washing grains out of dung and of sowing them	Number of grains of gram which produced strong healthy plants	Number of wheat grains which germinated and produced strong healthy plants
28-1-15	Green oats 24 seers *Bhusa* 6 ,,	30	Throughout the day.	2	2	1 hour	6 P.M.	*Nil.*	28-1-15 29-1-15	6 P.M. 7-30 A.M.	29-1-15	*Nil.* *Nil.*	55 178
29-1-15	Do.	30		3	2	Do.	Do.	$\frac{1}{16}$	29-1-15 30-1-15	6 P.M. 7-30 A.M.	30-1-15	*Nil.* *Nil.*	10 16
30-1-15	Do.	30		2	2	Do.	Do.	$\frac{1}{8}$	30-1-15 31-1-15	6 P.M. 7-30 A.M.	31-1-15	2 *Nil.*	97 5
31-1-15	Do.	30		*Nil.*	*Nil.*	...	...	...	31-1-15 1-2-15	6 P.M. 7-30 A.M.	1-2-15	*Nil.* *Nil.*	4 3

* The bullock was fed with wheat grains previous to 28-1-15. See Statements **I** to **VI** inclusive.

STATEMENT X.

Showing the vitality of gram and wheat grains after passing through the stomach of Bullock No. IV (age 11 years approx.).*

1	2				3				4		5	6	7
	FODDER				GRAM				DUNG COLLECTION				
Date of feeding	Particulars	Total weight given, in seers	Hours of feeding	Weight not eaten, in seers	Weight of unsoaked grain fed, in seers	Period of soakage before feeding	Hours of feeding	Weight of air dry grain not eaten, in seers	Date	Hour	Date of washing grains out of dung and of sowing them	Number of grains of gram which produced strong healthy plants	Number of wheat grains which germinated and produced strong healthy plants
28-1-15	Green oats 24 seers *Bhusa* 6 ,,	30	Throughout the day.	1½	2	1 hour	6 P.M.	*Nil.*	28-1-15 29-1-15	6 P.M. 7-30 A.M.	29-1-15	*Nil.* *Nil.*	3,722 2,015
29-1-15	Do. ...	30		2	2	Do.	Do.	*Nil.*	29-1-15 30-1-15	6 P.M. 7-30 A.M.	30-1-15	*Nil.* *Nil.*	1,067 140
30-1-15	Do. ...	30		1½	2	Do.	Do.	*Nil.*	30-1-15 31-1-15	6 P.M. 7-30 A.M.	31-1-15	*Nil.* *Nil.*	19 4
31-1-15	Do. ...	30		*Nil.*	*Nil.*	...	...	*Nil.*	31-1-15 1-2-15	6 P.M. 7 30 A.M.	1-2-15	1 *Nil.*	7 6

* The bullock was fed with wheat grains previous to 28-1-15. See Statements I to VI inclusive.

STATEMENT XI.

Showing the vitality of gram and wheat grains after passing through the stomach of Bullock No. V (age 8 years).*

1	2				3				4		5	6	7
	FODDER				GRAM				DUNG COLLECTION				
Date of feeding	Particulars	Total weight given, in seers	Hours of feeding	Weight not eaten, in seers	Weight of unsoaked grain fed, in seers	Period of soakage before feeding	Hours of feeding	Weight of air dry grain not eaten, in seers	Date	Hour	Date of washing grains out of dung and of sowing them	Number of grains of gram which produced strong healthy plants	Number of wheat grains which germinated and produced strong healthy plants
28-1-15	Green oats 24 seers *Bhusa* ... 6 ,,	30	Throughout the day.	$1\frac{1}{2}$	2	1 hour	6 P.M.	*Nil.*	28-1-15 29-1-15	6 P.M. 7-30 A.M.	29-1-15	*Nil.* *Nil.*	2,196 4,399
29-1-15	Do.	30		2	2	Do.	Do.	*Nil.*	29-1-15 30-1-15	6 P.M. 7-30 A.M.	30-1-15	*Nil.* *Nil.*	145 274
30-1-15	Do.	30		$2\frac{1}{2}$	2	Do.	Do.	$\frac{1}{16}$	30-1-15 31-1-15	6 P.M. 7-30 A.M.	31-1-15	*Nil.* *Nil.*	15 31
31-1-15	Do.	30		*Nil.*	*Nil.*	...		...	31-1-15 1-2-15	6 P.M. 7-30 A.M.	1-2-15	4 *Nil.*	36 15

* The bullock was fed with wheat grains previous to 28-1-15. See Statements I to VI inclusive.

Statement XII.

Showing the vitality of gram and wheat grains after passing through the stomach of Bullock No. VI (8 years old).*

1	2				3				4		5	6	7
	Fodder				Gram				Dung collection				
Date of feeding	Particulars	Total weight given, in seers	Hours of feeding	Weight not eaten, in seers	Weight of unsoaked grain fed, in seers	Period of soakage before feeding	Hours of feeding	Weight of air dry grain not eaten, in seers	Date	Hour	Date of washing grains out of dung and of sowing them	Number of grams which produced strong healthy plants	Number of wheat grains which germinated and produced strong healthy plants
28-1-15	Green oats 24 seers *Bhusa* ... 6 ,,	30	Throughout the day.	2	2	1 hour	6 P.M.	*Nil.*	28-1-15 29-1-15	6 P.M. 7-30 A.M.	29-1-15	*Nil.* *Nil.*	3,148 1,216
29-1-15	Do.	30		$1\frac{1}{2}$	2	Do.	Do.	$\frac{1}{16}$	29-1-15 30-1-15	6 P.M. 7-30 A.M.	30-1-15	*Nil.* *Nil.*	342 455
30-1-15	Do.	30		$2\frac{1}{2}$	2	Do.	Do.	$\frac{3}{16}$	30-1-15 31-1-15	6 P.M. 7-30 A.M.	31-1-15	*Nil.* *Nil.*	46 24
31-1-15	Do.	30		*Nil.*	*Nil.*	...	...	...	31-1-15 1-2-15	6 P.M. 7-30 A.M.	1-2-15	2 *Nil.*	29 24

* The bullock was fed with wheat grains previous to 28-1-15. See Statements **I** to **VI** inclusive.

STATEMENT XIII.

Showing the total number of wheat grains eaten by each bullock and the numbers which formed strong healthy plants after passing through the animals.

1	2	3	4	5			
Number of Bullock and its age	Weight of unsoaked wheat grain eaten by bullock, in seers.	Number of unsoaked wheat grains, per seer weight	Number of wheat grains eaten by bullock	NUMBER OF WHEAT GRAINS WHICH PRODUCED STRONG HEALTHY PLANTS AFTER PASSING THROUGH THE ANIMAL			
				Passed from 21-1-15 evening to 28-1-15 morning	Passed from 28-1-15 morning to 1-2-15 morning	Total	Per 100 grains eaten
I.—14 years approx. ...	$5\frac{1}{8}$	22,800	116,850	18,712	5,284	23,996	20·5
II.—13 years approx. ...	$13\frac{1}{4}$	Do.	302,100	33,036	10,673	43,709	14·4
III.—Over 14 years ..	$2\frac{1}{2}$	Do.	57,000	5,144	368	5,512	9·6
IV.—11 years ..	10	Do.	228,000	18,056	6,980	25,036	10·9
V.—8 years approx. ...	$13\frac{5}{8}$	Do.	310,650	28,200	7,111	35,311	11·3
VI.—8 years approx. ...	$11\frac{15}{16}$	Do.	272,175	36,588	5,284	41,872	15·4

THE SUITABILITY OF PUSA 12 WHEAT FOR LOCAL CONSUMPTION IN THE CENTRAL CIRCLE, UNITED PROVINCES.

BY

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THE advantages of this wheat over the ordinary soft white type usually exported from these provinces, from the point of view of the English miller, have already been pointed out by Mr. and Mrs. Howard in the various Pusa Bulletins on the Milling and Baking qualities of Wheats. The environment experiments carried out by the same workers in conjunction with Mr. Leake have amply demonstrated that the high commercial qualities of Pusa 12 wheat are maintained under very varying agricultural conditions. A series of careful trials in different parts of the Province have shown that Pusa 12 is undoubtedly suited for the greater part of the Central Circle ; the exceptions being Kheri—a submontane tract where Pusa 12 has not yet been extensively tried as Pusa 106 is doing well, and Bundelkhand where conditions are more those of Central India and where a wheat with a shorter growing season, such as Pusa 4, seems indicated.

Although most districts in this circle export considerable quantities of wheat, especially in good years, a large proportion is reserved for local consumption, much of which goes to feed the large industrial populations in such cities as Cawnpore. Lucknow and Allahabad. It is clear, therefore, that while yield is of paramount importance no new wheat is likely to replace *desi* wheat entirely unless it is adapted to the requirements of the local markets.

The first enquiries in this direction appear to have been made by Mr. Moreland (then Director of Land Records and Agriculture), samples of the new strong wheats produced at Pusa and of Muzaffarnagar wheat being distributed to representatives of different communities for practical trial. The opinions expressed seem to have been somewhat contradictory, some persons attaching extreme importance to the question of colour and others to the behaviour on cooking. The probable reason of this was that the experiments really amounted to a comparison of a weak white wheat with a red strong wheat and the reports showed that different persons attached a varying amount of importance to colour. The truth appears to be that for some purposes Indians find a white wheat essential but that a strong white wheat would be preferred to a weak white wheat. Pusa 12, being a white wheat, would appear to comply with these conditions and further enquiries have been made with a view to determining its suitability for Indian consumption.

It was early ascertained that the wheat was liked for eating purposes by the cultivators to whom it was issued for sowing purposes—with the exception of one enterprising individual who misapplied some of his seed and became acquainted for the first time with the taste of naphthalene. Arrangements were, therefore, made to have a series of tests carried out by members of the Mainpuri Agricultural Association. The writer is particularly indebted also to Rai Radha Raman Bahadur, Collector of Mainpuri, for a very careful test. Both Pusa 12 and 110 were issued, the latter being included since it appears to do rather well in that district and, though inferior to Pusa 12, may be found useful for those cultivators who insist on growing a bearded wheat.

Mr. Radha Raman's report is given below in full :—

" **Pusa 12** is an excellent wheat in every respect. I tried it in the form of both *puris* and *chapatis* and liked the taste. There is a lot of starch in this wheat and I am sure it is well suited to make flour (*maida*) of. Pusa 110 is also good but is decidedly a grain of a comparatively inferior quality."

The reference to the proportion of starch is not quite clear but is probably the writer's way of expressing the term " free-milling."

The following are literal translations of vernacular reports received from members of the Mainpuri Agricultural Association.

P. Kunwar Kalyan. Two kinds of wheat were sent to me for testing and their taste is as follows :—

Pusa 12.—The *puris* and *rotis* prepared from this wheat were very soft and tasted sweet ; the glutinousness[1] (*loch*) of the *ata* was good.

Pusa 110.—The *puris* and *rotis* prepared from this wheat were harder than those from Pusa 12, but better than from *desi* wheat.

Pandit Ram Lal (*a*). On preparing *rotis* and *puris* of Pusa 12 wheat I found that they were softer and sweeter than either those from *desi* or Muzaffarnagar wheat and tasted better, suggesting seasoning with *moman* (ghi and sugar).

(*b*). The *rotis* and *puris* prepared from Pusa 110 wheat were tougher but fragrant.

Babu Shyam Sundar Lal. On trying the two kinds of Pusa wheat sent to me it was found that both were superior for eating purposes (literally more delicious) to the *desi* wheat of this neighbourhood : the *rotis* and *puris* prepared from them were very soft and clear. Of the two kinds I prefer the one with the thick grain (Pusa 12).

Pandit Devi Dayal Pathak. Wheat Pusa 110 has a sweet and agreeable taste ; its bread is white and soft and is liked by all people for eating.

Wheat Pusa 12.—Its bread is not so soft as (that of) Pusa 110 and inferior (to it) in taste and is not liked as much as Pusa 110. The colour of the bread is also not so good.

M. Hakim Uddin. Pusa 110. *Rotis* prepared from this wheat are pleasant smelling suggesting parched rice and sweet, the taste is good and the bread rises well and the strength (*loch*) is good : the *ata* is also good and *rotis* kept over from the previous day remain good.

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[1] The Hindustani word *loch* used in most of these reports appears to be the nearest equivalent to "strength" as applied to flour.

The dough from *ata* of Pusa 12 when kneaded becomes stiff and bread left over till the next day becomes hard. The *rotis* are somewhat sticky in eating but the strength of the *ata* is good.

The originals of these vernacular reports have been published in the Department's Vernacular Journal, the *Mufid-ul-Mazarain*.

While it is not easy to find exact equivalents for some of the vernacular terms employed, it is clear that both these wheats are liked for Indian consumption though opinions differ as to their relative value. The samples were drawn from the crop grown on the Mainpuri Farm on land taken over from cultivators the previous year and are fairly representative of what may be expected in this district. Pusa 12 was better grown than Pusa 110 which suffered somewhat from a very wet March, and both were far better in appearance than local *desi* and Muzaffarnagar which were thin and rusted.

Equally significant was the fact that wherever it was sown Pusa 12 at once commanded a premium in the local bazaars chiefly on account of its appearance, so much so as to materially hamper the buying in of wheat for the shipment experiment which is in progress. It may safely be concluded, therefore, that though Pusa 12 wheat is being introduced largely because of its agricultural qualities (yield, standing power, water economy and slightly earlier ripening) it is suited not only to the export market but also to the local Indian market which in the United Provinces is no less important.

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THE CLASSIFICATION OF MANGO VARIETIES.

BY

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AND

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In India the number of mango varieties is immense. Watt[1] states that Maries collected some 500 varieties in India, but very few attempts have been made to describe these. Maries made a start by describing the varieties of his own district and the same has been done by one or two others, notably Woodrow and Hartless. One or two varieties have been carefully studied, but as a whole they have not been examined with a view to classification. Such a process is necessary if we are to have any definite knowledge as to the types of this fruit, and their distribution and possibilities. This *embarras de richesses* in forms of mango fruits has apparently existed in India for centuries. In 1638, we find Van Rheede writing "Caeterum fructuum horum Mangas, haud secus ac pomorum ac pyrorum nostratium variae dantur species, quæ pro regionum diversitate plurimum variant" (Translation—Of these other fruits, mangoes, not unlike our apples and pears, are found in several types, which vary greatly according to the nature of the region).

Without some classification we have chaos. According to what scheme can this chaos be reduced to order ?

[1] *Dictionary of Economic Products of India,* Vol. V, p. 149.

PLATE XIX.

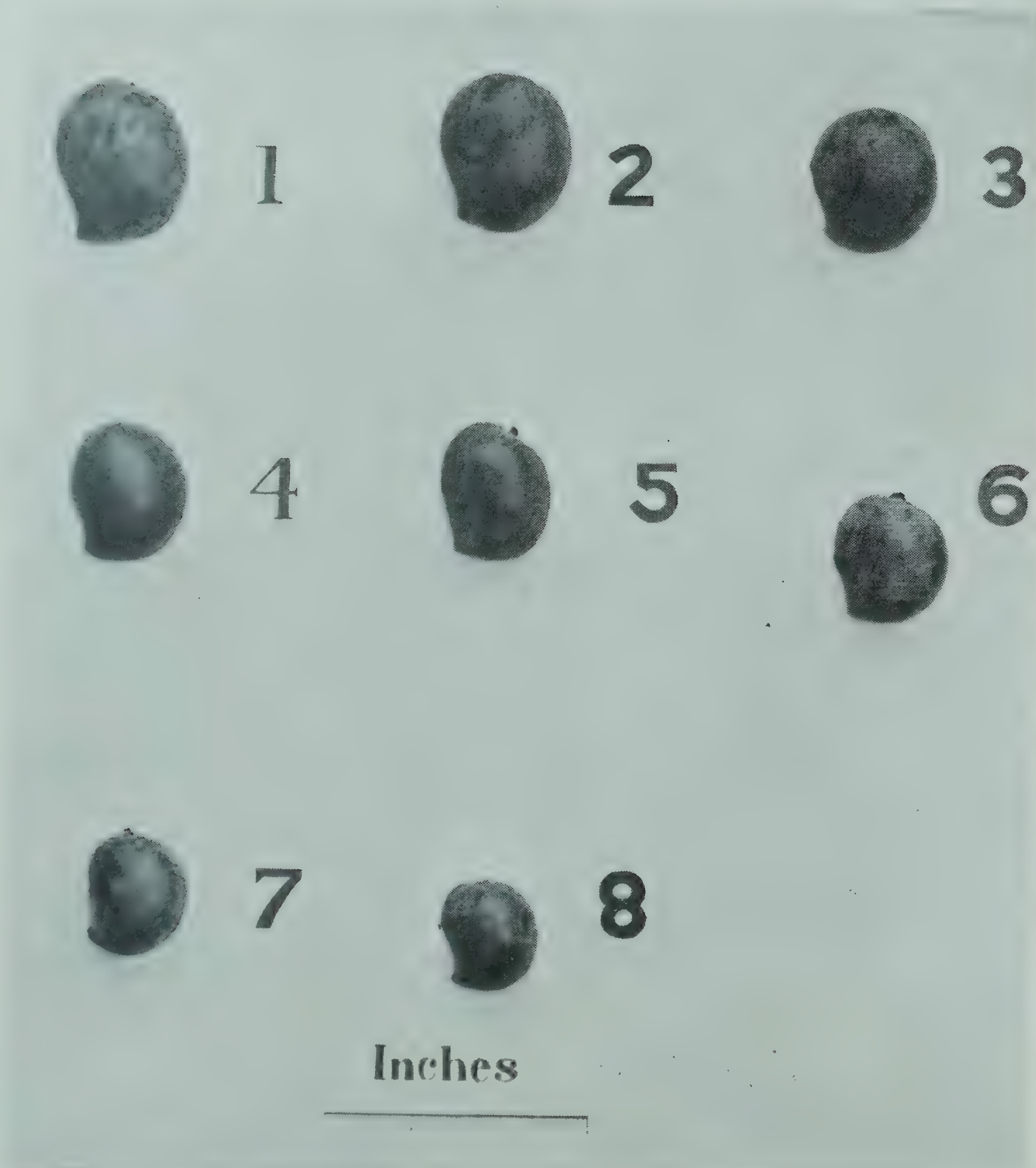

Fig. 1.
Mango fruits from one tree, of Pairi variety, showing constancy in shape and variation in size.

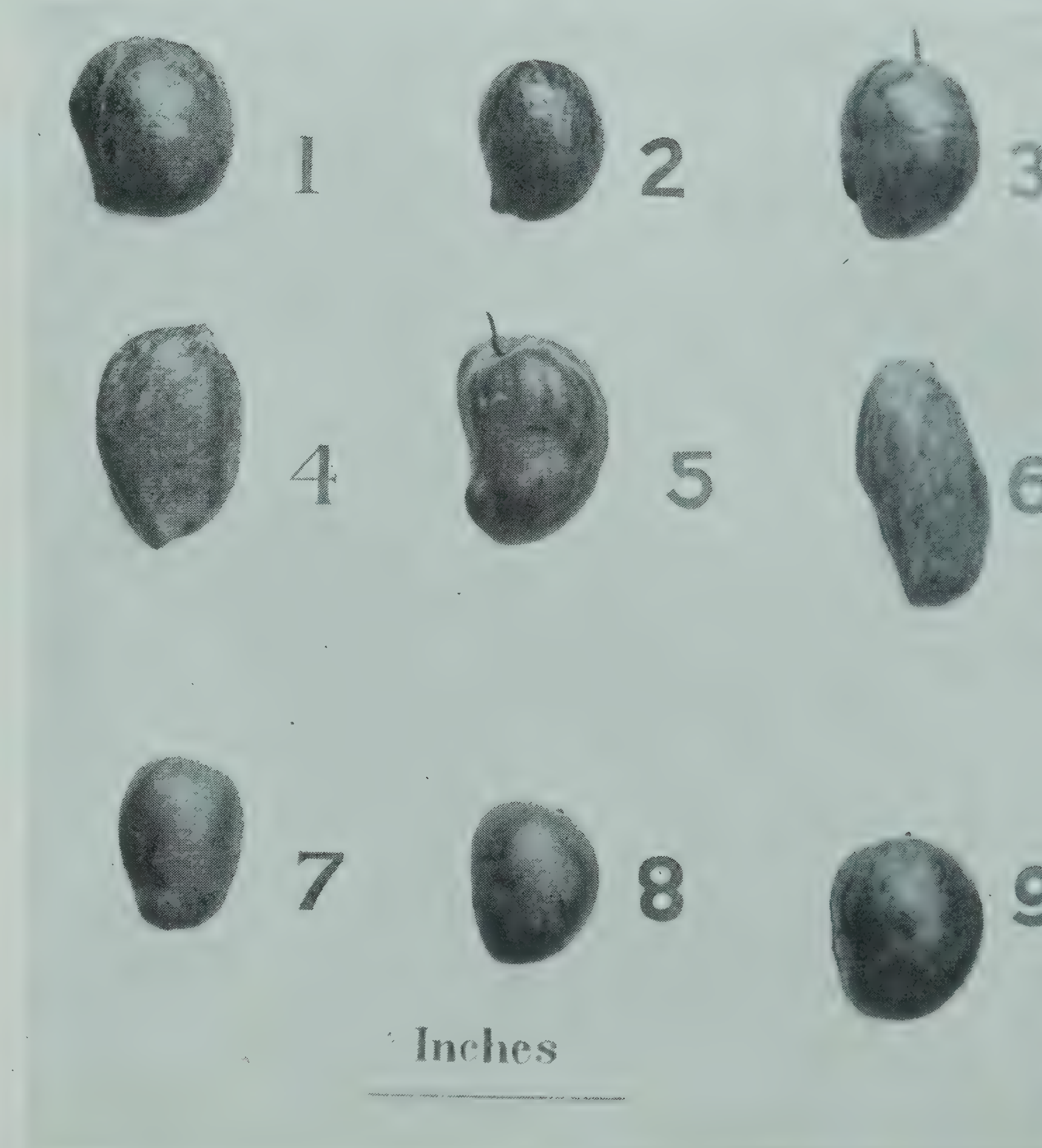

Fig. 2.
Mango fruits of different varieties, showing variation in shape.

In all classification the main point is to extract from a multitude of characters those which are *common* and *constant* in individuals or types. It seems to us that since mango trees are at present named and recognized by their fruit we should take the fruit as the part by which to classify. The least variable external character of the fruit in a given variety is the shape of the fruit. The size and weight vary considerably among fruits of the same tree. This is well shown in Fig. 1.

In contrast with the first figure stands fig. 2 which contains mangoes of different varieties, namely : –

1. Mothi Pairi.	6. Batli.
2. Pairi.	7. Borsha.
3. Khoont.	8. Alphonse.
4. Popatya.	9. Mulgoba.
5. Cowasji-Patel.	

The diversity in shape is at once apparent.

A classification based on fruit characters is undoubtedly artificial, but as a means for reducing to some kind of order the existing chaos of forms, an artificial is as good as a natural classification. Natural classification will come later when the existing forms have been catalogued and described.

In classifying mango fruits we may with reason follow the plan adopted in 1875 for the classification of grape varieties by the International Ampelographic Commission at Kolmar. The three main classes then suggested were—(1) Round fruited :—those varieties with fruits in which the length from stalk to apex is equal to or less than the breadth. (2) Long-fruited :—those varieties in which the length is distinctly greater than the breadth. (3) Indefinite :—those that fall in neither class, on account of being on the border line between the classes and in addition of somewhat variable nature.

To make the above strictly logical, class 1 should contain only those which have fruits with the axis from stalk to tip constantly shorter than the transverse axis and class 3 should contain the forms with both axes equal and also any doubtful or variable forms. A

somewhat similar classification was suggested by Woodhouse[1] for the mangoes of Bhagalpur.

This mention of axes means that we have to consider in what position a mango fruit should be for description. It is a useful convention to describe a mango fruit lying on its side with the beak to the left. One can then talk of its length, (axis between stalk and apex) breadth (axis at right angles to length and parallel to plane in which the mango fruit is lying) and thickness (axis at right angles to breadth and vertical to surface on which the fruit is lying).

In the above-mentioned article by Woodhouse and in a more recent article by Popenoe[2] the various parts of the fruit have been named, and the methods of description suggested. We may content ourselves with describing the parts named in Fig. 3, namely, right and left shoulders, basal cavity (attachment of stalk), beak, apex, and sinus (on left side). In addition, size in three dimensions, weight, colour, surface, and the nature, closeness and distribution of the small dots on the skin, should be described. After the fruit is cut the flesh should be described as to taste, colour and stringiness, the skin as to thickness, and the stone as to size, weight, fibre and markings. The following is an example of a mango fruit partly thus described :—

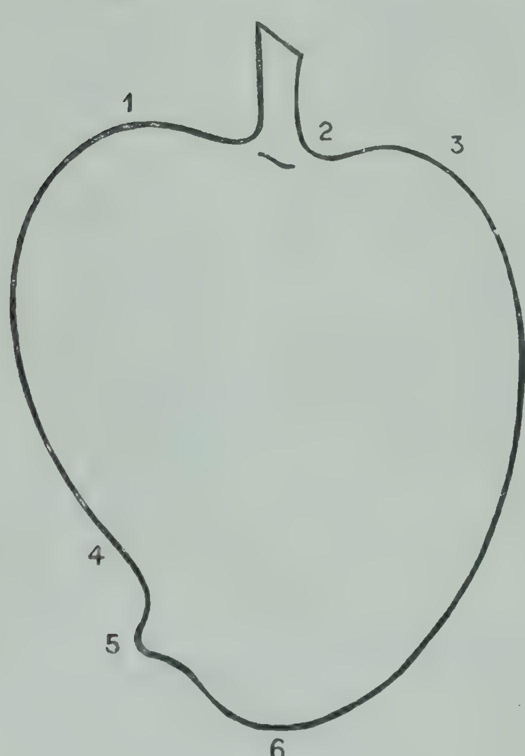

Fig. 3.

1. Left shoulder.
2. Basal cavity.
3. Right shoulder.
4. Sinus.
5. Beak.
6. Apex.

Dudh-Shendrya.—Weight 245 grammes, measurements $9 \times 6 \times 5$ cm., luscious, colour of the flesh pale yellow, no fibres, colour of the outer skin yellow to brick red, glands small white, slightly

[1] *Quarterly Journal of the Department of Agriculture, Bengal*, II, 168, Jan. 1909.

[2] *Proceedings of the American Pomological Society*, 1913.

rough, basal cavity slight, left shoulder slightly higher than right, beak slight, 2 cm. from apex, apex rounded, weight of stone 37 grammes and its measurements $7{\cdot}2 \times 4 \times 3{\cdot}2$ cm.

Such descriptions will enable us to put mangoes into classes subordinate to the main three classes just mentioned. These subordinate classes would be distinguished by the characteristic shape of the fruit, e.g., the Alphonse class with high left shoulder and small or missing beak. Under this would come all the varieties of the Alphonse shape, but differing in colour and taste, e.g. Alphonse, Fernandin, etc. In tabular form the scheme would work out as follows :—

Alphonse Class *Shape*

Name of variety	Taste	Pulp	General description
Alphonse ...	Very luscious and fragrant.	Reddish in the middle and pale yellow on the outside.	Left shoulder higher than the right; thin skin closely attached to flesh; dots minute.
Fernandin ...	Very luscious ...	Bright yellow ...	Bright red on exposed side and yellowish-green on non-exposed side; thick skin closely attached to flesh; surface rough and warty, with small yellow dots.
Madan Ban ...	Luscious ..	Yellow to red; thick consistency; no fibres.	Yellowish green; beak slightly present; both shoulders falling equally; small black dots present.
Popatia Class		*Shape*	
Popatia ...	Slightly acid, pleasant.	Yellow; rather tough; fibre small.	Fruit bulged in the middle and narrowed at the stalked end; green to red dots prominent and close.
Masana ...	Bitter ...	Pale yellow tough ...	Skin green and orange, small dots present; beak sharp and prominent.

If we desired to make a world-wide classification we should make territorial classes embodying the Indian, West Indian, Cuban, Philippine, &c., mangoes, and these could again be grouped under

the two great heads of monoembryonic and polyembryonic. So far only monoembryonic mangoes are known in India.

A word or two regarding the origin of mango names in the Bombay Presidency may not be out of place.

It seems that the Indian is somewhat eccentric when he comes to naming mango fruits and tacks a fanciful title on to every seedling that produces good fruits. A large number of these may frequently be traced to colour of the skin, shape, size, &c. The following instances will clearly show how some of the mango varieties have been named :—

How named	Examples
From outward colour ...	Dalimbya (like the colour of pomegranate). Kalya (dark coloured fruit).
,, shape	Batli (like a bottle). Kelya (like a plantain). Popatia (beak like a parrot). Ladu (ball-like).
,, certain outside marks ...	Nakya (one having prominent nose or beak). Bhokya (one with a hole).
,, size	Naralya (big as a coconut). Mahalungya (like a citron).
After some persons	Alphonse (after Alphonso) Cowasji-Patel (a proper name). Karel (Carriera). Collace (doubtful).
After some titles or great personages .	Maharaja—King. Maharani—Queen. Badashaha—Emperor. Baji Rao—One of the Maratha Peshvas. Birbal—The prime minister of Akbar. Chhatrapati—King.
After some romantic ideas ...	Madanban (arrow of Cupid). Dilhouse, Dilpasant, Dilbahar, Dilkhush } delight of the heart.
From consistency	Dahi-amba (curd-like). Pithya (flour-like). Khobarya (like the kernel of a coconut).
,, the smell of the juice ...	Shepya (like *Peucedanum graveolens*).
After surroundings	Saundadya (Saundad—*Prosopis spicigera*) that stood quite close to a mango tree. Warulya (owing to its nearness to a big white ant hill) Warul meaning an ant-hill.
After the general arrangement of the fruits on the inflorescence stalk.	Toranya, Ghad-amba } Cluster-like.

In some cases where the fruits resemble each other in shape, but differ in other characters, some words either denoting size or

place are prefixed, thus Mothi Pairi denotes that it resembles Pairi in shape but is big in size. Similarly, Pachkodi-Dodi and Hiswalchi-Dodi resemble Dodi mango in shape, but are named after their respective places, as they differ in other characters.

We thus find that the names give us no help in the methods of classification as it is likely that the same name has been given to more than one variety or the same variety may occur under different names in different localities.

The results of an arbitrary classification based on fruit characters may lead us some little way towards determining the ancestral type or types from which our present mango varieties have sprung. This will be of great scientific interest, and may also be of practical value in assisting us to produce new forms.

This year, both in Ganeshkhind and Bassein Botanical Gardens, hybrid fruits have been secured in first crossings of mango varieties. The fruits produced by the next generation will be awaited with interest as they may give us a lead in determining which of the present existing forms are hybrid, and a hint as to their parentage.

GREEN-MANURING IN THE CENTRAL PROVINCES.

BY

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THE problem of the satisfactory use of a green-manuring crop in increasing soil fertility is a somewhat difficult one under the climatic conditions prevalent in the Central Provinces. Green-manuring can be used with one of several objects in view (1) the grading up of poor light soils by increasing the humus, (2) the raising of the value of land which has physically deteriorated by bad farming, (3) as a direct form of manuring, *i.e.*, by the replacement of a certain bulk of farmyard manure. There is no doubt that in (2) and (3) the action is similar ; but in the former the essential value lies in the humus supplied, in the latter the user's attention is fixed on the nitrogen added, and the increased chemical fertility which may result. The use of green manures in countries in which the climate, though for a short period wet, may be described as arid, and in which humus appears to play a smaller part in producing fertility and a good physical state than in wetter and more temperate conditions must probably be looked on as a form of direct manuring, even allowing that the humus added in the process, if satisfactorily performed, is of value.

It is now proposed to deal with the material available locally, remarking by way of preface that except in one or two non-experimental cases the use of this process of green-manuring has had for its object direct manuring by the replacement of farmyard manure. After dealing with such evidence an attempt will be made

to indicate what it would seem to point to under local conditions, which are, after all, typical of a large section of the country.

Except in the case of paddy and of one or two experiments of somewhat doubtful value economically or otherwise, green-manuring has been a precursor to a *rabi* crop—almost invariably wheat.

Plants used for the purpose.

The following have been used. *Dhaincha* (*Sesbania*), *san* (*Crotalaria juncea*), *tarota* (*Cassia occidentalis*), *bawchi* (*Psoralea corylifolia*), *kulthi* (*Dolichos uniflorus*), wild indigo, *kadoojira* (*Vernonia cinerea*).

All except the last named are leguminous, the last belonging to the *Compositæ*. Except in the cases of *dhaincha*, *san*, and *kulthi*, which have been ploughed in where they grew, the others have been collected from other fields and applied by the cart-load. The material was then ploughed in. This system is expensive ; possibly it is not economic, but it appears to have results which may cast some light on the problem.

The application and methods of inversion.

There are three direct methods of using a green crop :—

(1) Collection from outside, spreading and mixing with the soil by cultivation with the inverting plough or even the country plough,

(2) growth and ploughing in, when of a desired height, as it stands by the use of an inverting plough,

(3) growth followed by the opening up of the field with a country plough in the furrows of which, the green crop, cut in bunches, is laid, and earthed up by the next furrow.

The last system is the local country method and ensures, under some conditions, a better covering of a crop like *san* than the simple use of an inversion plough unless following a " planker " to lay the crop or used with a " jointer " and chain to drag in the long stuff.

There are two methods by which an indirect use is made of the green crop. Though neither are strictly green-manuring, the second appears to have sound features:—

(1) Growing a green crop and feeding it off as it stands followed by the subsequent cultivation of the land—analogous to sheep folding on mustard in England.

(2) The growth of a rapid maturing leguminous crop in the monsoon—its early harvesting for fodder or seed, and the subsequent inversion of the stubble, before sowing wheat, irrigated or unirrigated.

The first of these is perhaps not of very great value, because on the heavy soils in which wheat is likely to be grown, feeding off (especially by sheep) is rarely likely to be possible without puddling the land. In spells of dry weather, however, dairy stock can be turned on early in August, to graze off a *san* crop which appears to be too luxuriant and the immediate inversion of which is impossible owing to other cultivation work. The wheat crop following is generally distinctly satisfactory.

The second method is really double cropping. It may, however, be considered as partial green-manuring and from observation the writer is led to believe that it is a practice which is applicable under conditions when a complete inversion is impossible.

Factors desirable in a green-manuring crop.

We may take it that the following points are desirable in the crop used, though few, if any, of such crops comply with the standard in all respects :—

(1) A leafy habit, and heavy growth,

(2) a soft, non-fibrous character, indicating rapid decomposition,

(3) a deep root-system, opening the soil,

(4) a good nodular growth, as indicative of rapid nitrogen absorption,

(5) a rapid, early growth.

Taking green crops generally, *dhaincha, bawchi* and cowpea comply with the first condition ; cowpea, *kulthi* and *kadoojira* the second ; *dhaincha* and *tarota*, the third ; *dhaincha, san* and wild indigo the fourth ; and *san, kadoojira*, and *tarota* the last. The first is no doubt an important factor in areas like Eastern Bengal and Assam, and if associated with two or three of the other factors renders the particular crop possessing them specially suitable for green-manuring. This no doubt accounts for the strong preference given to *dhaincha* in such provinces where water and time are not of special consideration. In areas with climatic conditions like those in the Central Provinces, and in areas where irrigation cannot ameliorate time and water defects, No. 5 becomes the dominant factor, closely associated with 2 and 4, thus making *san* a more suitable crop for these localities than *dhaincha*. We can thus perhaps divide the country into areas in which factors 1, 3, and 4 are most desirable and into areas in which factors 5, 4, and 2 are essential. The writer's observations have been in areas of the second type.

Green-manuring previous to crops other than wheat or rabi crops.

This can be briefly dealt with and does not have much effect on the principles and difficulties of the question.

Green-manuring before paddy.

This has been experimentally tried at Raipur. The green crops used are *san* and *dhaincha*. The former is the more rapid, the latter though standing the constantly water-logged state of the land better is very slow in the early stages. Both are sown at the break of the monsoon. As far as his memory goes the writer has never seen a tall, thick, or heavy crop of either at the time of inversion. Indeed the stand has generally been poor. Inversion takes place before transplanting.

The following is a tabulated statement of results obtained here to date. In all cases transplanting has immediately followed

ploughing in, the first series being so treated at the beginning of August and the second about the middle of that month.

	1911-12 Paddy		1912-13 Paddy		1913-14 Paddy		Average	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
(1) *San* ...	570	550	860	850	810	790	747	730
Sawri (Dhaincha).	680	610	610	630	910	920	733	720
No manure ..	450	433	500	440	640	560	530	517
(2) *San* ...	490	460	880	840	700	810	690	703
Sawri ...	500	500	690	640	800	910	617	683
No manure ...	360	370	610	640	470	450	460	487

Average of *san* over no manure—223 lb. grain.
,, *sawri* ,, —203 ,,

The results of two years prove *dhaincha* to be a little more satisfactory than *san*. In 1912-13 the monsoon was late and *sawri* was only some 5 inches high at the time of inversion. In the other, rather wetter, years the *san* suffered more from water-logging. Inversion and transplanting at a later date do not appear to add to the outturn ; though as a consequence of delay a slightly bigger crop may be inverted, yet the late transplantation probably affects the tillering of the paddy. The writer ventures to suggest that a better method, where irrigation is available in the hot weather (which is not commonly the case in the Central Provinces), is to start the green crop a fortnight or so before the general break of the monsoon. *San* once established is capable of standing more water.

San has also been used over all the manurial paddy series on the Farm to raise the fertility of the unmanured plot without altering its relative fertility in the series.

There has been a general improvement over the series, but the relative values of the manures applied in the series do not appear to have been maintained ; in five out of six plots in which bone dust has been the applied artificial, the effect of the combination has been extraordinary. This is in line with Hopkins' system of maintaining soil fertility and Meggitt's note to the Board of Agriculture in 1911.

The following figures to illustrate the point are taken from the Raipur Farm Report, 1912-13 :—

Series transplanted paddy without irrigation.

	Before green-manuring	After green-manuring	Average increased yields of phosphate plots due to green manure
	lb.	lb.	lb.
Average yield of plots to which phosphate was applied.	1,490	2,043	......
Average yield of plots to which no phosphate was applied.	1,346	1,412	... ..
Average increase due to phosphate ...	144	631	487

1912-13.

Series irrigated transplanted rice.

	Before green-manuring	After green-manuring	Average increased yields of phosphate plots due to green manure
	lb.	lb.	lb.
Average yield of plots to which phosphate was applied.	1,199	1,773	......
Average yield of plots to which no phosphate was applied.	1,067	1,277	......
Increase due to phosphate	132	496	364

1913-14.

Series of transplanted paddy without irrigation on different plots from those used, 1912-13.

	Before green-manuring	After green-manuring	Average increased yield of phosphate plots due to green-manuring
	lb.	lb.	lb.
Average yield of plots to which phosphate was applied.	1,504	1,603	......
Average yield of plots to which no phosphate was applied.	1,386	1,281	... ..
Increase due to phosphate	118	322	204

The only artificial manure in the rest of the series which has apparently been affected by the presence of the green manure and has reacted on the paddy is calcium cyanamide.

	Before green-manuring	After green-manuring	Increased yield due to green-manuring
	lb.	lb.	lb.
Average of 3 plots dressed with calcium cyanamide	1,005	1,240	235

Generally speaking green-manuring pays in paddy cropping and can be recommended for practice. Probably the results are enhanced if the sowing of the green crop can be done before the monsoon and if the green-manuring treatment is accompanied by the use of phosphates, which in the opinion of the writer are best applied, at the time of sowing the green manure crop.

Green-manuring for kharif crops the year previous to the crop.

This is not a practice which is likely to become common. It has only been adopted with favourable results by the writer in one or two non-experimental cases where land was in poor condition. There is only one case to hand of actual experimental trial. This was in a wheat-cotton rotation; in one plot the wheat was green-manured and in the alternative plot unmanured.

The following is the average of the 12 years in which the experiment was conducted :—

	Green-manured every alternate year before wheat	Unmanured
	lb.	lb.
Average return wheat ...	486 grain	266 grain.
Average return cotton ...	336 *Kapas*	274 *Kapas*.

The green manure applied for the first 8 years was *Psoralea corylifolia* and latterly *Vernonia cinerea*, in both cases the weeds were collected from waste areas and spread on the land and ploughed

in. In no case is there any record of the amount of green stuff used. One or two cotton growers have adopted a somewhat similar treatment—when cattle manure is too expensive for use on a large scale.

San or *sawri* (*dhaincha*) is sown, ploughed in in August, and followed by gram that year, giving place next year to cotton. The followers of this system, which is probably based on the experiment quoted, were perfectly satisfied with the results they got with their cotton, which were well above the yields on unmanured land.

Green-manuring before Rabi Crops.

On this point a very large number of experiments have been done. The practice appears to have certain obvious advantages if it can be done on an economic basis. All the problems of this system of manuring centre round the questions :—Under what conditions can the system be commended ? What factors will tend to a satisfactory result or the reverse ? What modifications will render it applicable under climatic conditions which are either obviously unsuited to the ordinary forms of application or apt to render them unreliable ?

In attempting to answer these questions partially it is proposed to leave out entirely the consideration of those areas in which the practice appears more or less bound to be satisfactory—areas under a heavier and longer monsoon, and areas in which an ample canal irrigation can be used to replace the natural moisture—partly because the writer has no direct experience and partly because as far as can be deduced from experiment under less satisfactory conditions, they do not offer any very serious problems. Consideration will therefore be confined to green-manuring before dry wheat, and green-manuring before wheat when a limited irrigation is possible.

Green-manuring in the experiments at Nagpur has taken two forms :—

(*a*) The use of local weeds collected and ploughed in.

(*b*) The use of *san* as a crop sown for the purpose.

In the first series there have been three experiments each of 10 years' duration, the results were, on an average of 10 years :—

	lb.		lb.
In (1) Green-manured ...	634	Increase	142
No manure ...	492		
In (2) Green-manured ...	520	Increase	196
No manure ...	324		
In (3) Green-manured ...	412	Increase	47
No manure ...	365		
			385
		Average ...	128

In the second series, there have been two experiments of long continued character, the first irrigated and the second unirrigated. The average of 20 years' results were :—

	lb.		lb.
(1) Green-manured with *san* ..	694	Increase ..	199
Unmanured	495		
(2) Green-manured	565	Increase ...	85
Unmanured	480		

The green manure always appears to have been ploughed in about the 20th of August. If we can place any reliance on these experiments there is a tendency towards better results in the first series than in the second, in the absence of irrigation. In these experiments there appears to have been no very great effort to stick to the same weed *kadoojira* (*Vernonia cinerea*) and *bawachi* (*Psoralea corylifolia*) and even cut *san* being used. The chief value of these experiments lies in their indication of the need of water for satisfactory results and in their support of the experiments now in progress at Hoshangabad where *tarota* is used on one plot, being cut and applied, and *san* in another, grown and applied. Here also we have a bigger gain from the former,

	Wheat grain.	Gain over No. 3.
	lb.	
(1) *Tarota* plot	916	146
(2) *San* plot	806	36
(3) Unmanured	770	

as shown in the Nagpur figures.

The principal requirements for successful green-manuring are the complete or practically complete decomposition of the green-manuring crop in the soil before the crop which it is intended to manure is sown, and a sufficiency of water in the soil to permit of the full development of the second crop. Both are important. In the writer's observation the presence of undecomposed and decomposing organic material in the soil at the time of wheat sowing leads to defective germination and to the early death of many germinated plants, which subsequent irrigation, though it may make good the sufficiency of water for later development, cannot rectify. Not infrequently the death of young plants under the above condition could not be attributed to a definite lack of sufficient moisture at the time of their death.

Successful decomposition before the sowing of the main crop appears associated with the quality and the character of the green crop, the moisture received between ploughing in and sowing and the time which is allowed to elapse between these two operations. In the three experiments with green manure and no manure in series 1, and in the unirrigated experiment in series 2, (p. 388) where only natural precipitation between ploughing and sowing was relied on, the better average increases shown in series 1 as a whole over experiment 2 of series 2 are accounted for by (*a*) the smaller amounts of green manure used in the first of these two series and (*b*) the soft fibreless character of the material used in experiments 1 and 2 of the first series. The greater advantage gained in the experiments 1 and 2 of the first series in which *kadoojira* and *bawachi* were principally used, as against cut *san* the most frequent source of supply in the third experiment of series 1 may be put down to the same reason.

The importance of a sufficiency of moisture to allow of decomposition of the green stuff before sowing and the subsequent development of the wheat crop is clearly shown on reference to the two graphs opposite. The first of these shows the average gain of wheat from all green-manured plots between 1884—1903 over unmanured wheat in comparison with the rainfall received after ploughing in. With the notable exception of the year 1891-92, for which the

writer can give no explanation, the two curves follow each other fairly closely. The second of these shows the results of an existing experiment in three satisfactory experimental years, *i.e.*, years in which green-manuring was not vitiated by external factors, for instance stray cattle as in 1913-14 and ploughing in when the soil was too wet as in 1912-13. In this experiment quantity and quality of material and to some extent the length of time which elapsed between ploughing in and sowing may undoubtedly be credited with some share in the results, but the remarkably close connection between the outturn and the amount of moisture received between ploughing in and sowing indicated the great importance of this factor.

The writer is convinced that if even irrigated wheat is to benefit by green manure, it is more important to irrigate before sowing the wheat in order to get a successful germination and establishment of the crop, than after, if the rainfall between inversion and sowing is short. Certain figures from Raipur support this statement and the generality shown in the graphs from the experiments on the Nagpur farm.

	Approximate date of inversion	Rain before sowing wheat and after ploughing in the green manure	Approximate irrigation before sowing wheat	Gain	Loss
				lb.	lb.
1908-09	1-9-08	12·3″	... ...	140	...
1909-10	1-9 09	10·5″	... ...	50	...
1910-11	1-9-10	5·8″	... ...	...	310
1911-12 (1)	18-8-12	10·79″	3″	115	...
..... (2)	1-9-12	7·10″	3″	45	...
1913-14 (1)	17-8-12	7·48″	......	...	25
...... (2)	29 8-12	5·63″	......	...	11·5

In the first three years irrigation was given in the cold weather. This does not appear to have made good the deficiency in 1909-10 and 1910-11. The natural rainfalls of the years 1908-09—1909-10, were practically the same as the total water of 1912 (1) and (2). The results are similar. In the other three cases the loss over the unmanured plot varies inversely with the amount of rain. The results follow those of the two graphs. Rainfall or water below 10″ produce

a loss or an unpaying gain. The time which elapsed after ploughing was sufficient for decomposition provided water was sufficient when ploughing in was done as late as September 1st. Within reasonable limits from the time of sowing, provided sufficient moisture is present, there is generally sufficient time to allow of complete or practically complete decomposition. Earlier inversion is in short of more value for the additional chance it gives the land of catching extra rain to produce decomposition than for merely the extra time it gives decomposition under ordinary circumstances to do its work. If moisture is ample, too long a period between inversion and sowing may indeed cause partial loss of the manurial value of the process. In the dry areas in which the writer is engaged earliness is important as giving a better chance for a sufficiency of moisture. The only alternative to irrigation after the monsoon and before sowing wheat is to start the green crop earlier by the help of irrigation before the monsoon and thus be in a position to plough in a larger bulk earlier, getting thereby a longer spell of natural water to assist decomposition. As irrigation water is, however, more likely to be available in September than in May or June the former is likely to be commoner practice.

The figures at Hoshangabad (*see* the table on the next page) do not follow those at Nagpur and Raipur with anything like the same exactness. On this farm we are dealing with a particularly clayey loam which holds the moisture. The difficulty of green-manuring is to find a day in July and early August on which the land is fit to plough, while the retentiveness of the soil assists any slight falling off in the rainfall. The writer is inclined to agree with Mr. Evans, supported by his own series at Nagpur in the present year that the factor of the condition of the soil, when ploughing is done, may entirely mask the effect of the manure; if ploughed too wet the bad effect produced on the tilth is greater than the good done by the manure.

The writer is also of the opinion, though not in a position to give direct proof, that as far as wheat is concerned, on dry soils, the growth of a legume which can be cut down and removed by the middle of August, is possibly as effective and safer, for the following

Results of Green Manure Experiments, Government Experimental Farm, Powarkhera, for 10 seasons.

Year	Date of green-manuring	Date of sowing wheat	Rainfall in monsoon June to September	Rainfall after ploughing in to time of sowing	Number of irrigations given all after sowing	When given	Return of green-manured wheat	Return of unmanured wheat	Remarks
			Inches	Inches			lb.	lb.	
1904-05	San hemp 21-8-04 ...	21-10-04	26·08	8·07	*Nil*	*Nil*	665	...	Irrigation was not given for want of irrigation arrangement.
	Tarota 23-8-04 ...	21-10-04		7·82	do.	do.	750	563	Had ¼″ rain in the middle of December.
1905-06	San-hemp 18-8-05 ...	24-10-05	48·96	19·88	2	1-1-06, 20-1-06	915	890	No winter rain.
	Tarota 21-8-05 ...	24-10-05		18·29	2	1-1-06, 20-1-06	1,253		
1906-07	San-hemp 10-8-06 ...	28-10-06	34·13	12·53	2	8-12-06, 17-1-07	859	680	No winter rain.
	Tarota 14-8-06 ...	28-10-06		12·53	2	8-12-06, 17-1-07	906		
1907-08	San-hemp 18-8-07 ...	21-10-07	36·43	6·82	2	12-12-07, 18-1-08	670	862	32 cents rain in the last of November.
	Tarota 18-8-07 ...	21-10-07			2	11-12-07, 18-1-08	796		
1908-09	San-hemp 5-8-08 ...	19-10-08	36·93		2	17-11-08, 23-12-08	860	692	59 cents rain in the beginning of November.
	Tarota 5-8-08 ...	19-10-08			2	17-11-08, 23-12-08	755		
1909-10	San-hemp 3-8-09 ...	21-10-09	32·32	12·89	1	24-11-09	596	737	1·67″ rain in the second half of December.
	Tarota 3-8-09 ...	21-10-09			1	23-11-09	852		
1910-11	San-hemp 31-7-10 ...	4-11-10	48·48	32·37	1	5-12-10	575	680	1·44″ rain in the first half of November.
	Tarota 31-7-10 ...	4-11-10			1	6-12-10	660		
1911-12	San-hemp 9-8-11 ...	27-10-11	38·11	23·22	1	21-1-12	918	637	2·41″ rain in the latter half of November.
	Tarota 9-8-11 ...	27-10-11			1	22-1-12	1,012		
1912-13	San-hemp 20-8-12 ...	25-10-12	40·74	7·27	1	20-1-13	1,150	992	3·92″ rain in the latter half of November.
	Tarota 20-8-12 ...	25-10-12			1	4-2-13	1,270		
1913-14	San-hemp 8-8-13 ...	22-10-13	45·47	11·52	1	10-1-14	958	968	1·44″ rain in the first week of December.
	Tarota 9-8-13 ...	23-10-13			1	9-1-14	905		

wheat crop. More uniform and regular wheat returns have been obtained by growing *san* and cutting it as fodder in August, than by ordinary green-manuring. And with irrigation facilities Mr. Clouston has got excellent wheat results following groundnut, the latter crop being in his case irrigated, as the groundnut is not off the land soon enough to permit a collection of natural precipitation in the soil. For this reason it is probably justifiable to look on the factor " Increase of Nitrogen " as the principal object in view, and to regard this double cropping with the inversion of an appreciable leguminous stubble as a form of green-manuring.

As regards green-manuring before wheat under dry conditions in climates of the Central Provinces type, that is with a rainfall of say 40″ in the monsoon compressed into the period between 15th June and 15th September, not infrequently beginning later and stopping earlier, experience seems to show :—

(*a*) that earliness of inversion is more important than quantity,

(*b*) that the material should be in by the first week of August. It is desirable therefore to sow with the first rains and to use either a quick crop like *san* or to collect weeds and apply (a method on the whole, which appears to give better results but at too costly a rate),

(*c*) that success is not likely unless at least 12″ or better, 16″ of rain is received after ploughing in while below 9″ or 10″ the results are not safe and the process is definitely inadvisable,

(*d*) that the condition under which ploughing is done must be kept in mind in judging the results and the effect of getting on the land at the wrong time allowed for if necessary,

(*e*) that when irrigation is available, either earlier sowing of the green crop is advisable, or, if the natural precipitation falls below the minimum of 9″ the use of water to supplement the natural precipitation in rotting the green manure. Such irrigation must be applied before, not after, sowing the wheat,

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(*f*) in areas where a rainfall of 12″ after August the 1st cannot be relied on, some increased fertility can be gained by the growth of a legume and its use for fodder in the monsoon. In this case it is desirable to invert the stubble by mid-August so as to allow of consolidation by the latter rains before sowing wheat. Probably 6″-7″ of rain after this will produce a satisfactory wheat crop. Unless added fertility is however essential, with a low late rainfall a cultivated summer fallow is probably safer practice,

(*g*) in areas with a rainfall of less than 35″ of ordinary monsoon distribution, green-manuring for a *rabi* crop is practically out of the question.

R

MANGO-HOPPER CONTROL EXPERIMENTS.

BY

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EXPERIMENTS in the control of the mango-hopper *Idiocerus niveosparsus* were begun at the end of 1913 and beginning of 1914. These were initiated too late in the season to be of any benefit to the trees experimented upon and no results of any value were obtained.

In December, 1914, another series of experiments was taken in hand. These were carried out in two tracts, one near Salem in a tope belonging to the Salem Zemindary at Varagambady and another at various places round Chittoor.

Both were conducted on the same plan. The results of the control measures taken in the Chittoor District were largely of no value as the flowering season was a bad one. At Varagambady, however, more conclusive results were obtained, and it is with these more especially that this paper deals.

Fifty-five trees were selected for the experiment. These trees were mostly fifteen years of age and were all grafted trees yielding valuable fruit. The whole tope, which was divided into two portions, consisted of some 800 trees. At the beginning of the season owing to some unknown cause, there were only comparatively few hoppers and at first it seemed as though the experiment would be inconclusive for this reason.

As the season progressed the numbers increased, but the conditions were not so serious as they were at a corresponding season in 1913-14. On the whole, the results obtained were sufficiently

encouraging to give hopes of even more complete success in the 1915-16 season.

THE PEST.

Idiocerus niveosparsus is the cause of great annual loss to mango growers of Chittoor and Salem. In a badly attacked mango tope the trees are covered with sticky secretion, the flower shoots blacken and wither and no fruit is set. The continual tap-tapping of the insects as they fly from leaf to leaf resembles the sound of a shower of rain falling on the trees. A really severe attack means the total loss of the crop and the greatly diminished vitality of the trees.

Idiocerus lays its eggs in little slits made in the tender leaf and flower shoots. There are apparently many broods in the year and the life history is a short one. The young hoppers emerging from the eggs feed at once on the leaf or flower shoots, and the little black marks made by the continual puncturing of the tissues can easily be distinguished. Eventually the flower shoot is either incapable of producing fully formed fruit or else dries up completely. In addition to the puncturing of the tissues of the new shoots a large quantity of " honey dew " is secreted and covers the leaves of the affected trees.

The adult insects are extremely active and are therefore beyond the power of the spraying machine to harm them.

With this fact before us it was decided to begin spraying directly the young shoots were formed so as to kill as many nymphs as possible before they attained their wings.

The insecticide selected was Crude Oil Emulsion, and it was applied by means of a Holder pressure sprayer of 10 gallons capacity. 1 lb. of emulsion was used for 10 gallons of water.

A careful watch was kept on the trees, and as soon as new shoots were put forth, spraying was begun. Inevitably some trees were sprayed more frequently than others as they flowered or put out new leaves earlier than others.

Once a tree had produced new leaves it was sprayed once in every ten days and latterly every eight days until the fruit had

set and it was considered to be beyond the power of the pest to harm it. In future experiments the spraying will be done every eight days from the beginning. Spraying lasted from the beginning of December to end of March.

The spray was distributed over the whole tree and the trunk. Special attention was paid to the leaf shoots and flower heads on which the nymphs and adults clustered. Towards the end of the experiment one or two sprayings were done with a Fish-oil Soap made by the Oil Expert to the Fisheries Department, Madras. This was a most satisfactory mixture for it stuck all the insects it hit to the shoots, leaves, etc., upon which they were resting, and one could see the gratifying results of the havoc which it wrought in the ranks of the hoppers. This soap should prove superior to crude oil and will probably be cheaper.

The total average cost of the sprayings was estimated at 8 annas a tree. This is a very liberal estimate, $6\frac{1}{2}$ to 7 annas being probably more nearly the real cost. But even at 8 annas the cost was justified by the results obtained. In the previous year not a single mango was sold from this tope, and the crop owing to the hopper was a total and complete failure.

Appended is a table showing the number of trees sprayed and the harvest gathered therefrom. The control trees were taken at random. One of these produced 500 mangoes, but was absolutely exceptional and had not suffered at all from the hoppers. The remaining trees were much closer to the usual condition of trees in a badly attacked tope

The total number of fruits gathered from the sprayed trees amounts to 2,044. Five of these trees produced no flowers at all and nine flowered so late in the season that in any case very few mangoes could be produced. If the harvest from No. 1 control be deducted, as it legitimately may be since it is obviously an abnormal tree, the yield from the unsprayed trees was 642.

This would bring in a return of Rs. 24, while the sprayed trees would be worth Rs. 80, at Rs. 4 per hundred. If Rs. 25 be deducted for the cost of spraying a substantial profit is still left. There is little doubt that spraying is profitable.

Sprayed trees			Control	
Number of tree	Number of sprayings	Number of mangos gathered	Number of tree	Number of mangos harvested
* 1	1	0	1	500
2	7	47	2	10
3	7	5	3	*Nil*
4	7	250	4	...
5	9	100	5	5
6	9	250	6	...
7	13	31	7	25
* 8	5	0	8	40
9	8	10	9	25
* 10	11	0	10	50
11	10	5	11	10
12	10	40	12	...
13	8	45	13	...
* 14	7	0	14	...
* 15	7	0	15	15
16	12	25	16	...
17	12	200	17	...
18	9	25	18	25
* 19	0	...	19	5
20	12	100	20	...
* 21	5	0	21	...
22	7	5	22	...
* 23	5	0	23	...
24	11	40	24	30
* 25	5	10	25	10
* 26	5	0	26	150
27	7	0	27	150
28	8	25	28	15
29	7	80	29	40
30	7	5	30	...
* 31	4	0	31	...
32	7	10	32	...
33	6	5	33	...
34	7	5	34	...
35	13	5	35	5
36	6	100	36	...
37	4	5	37	...
* 38	...	...	38	10
39	7	150	39	...
* 40	...	...	40	...
41	7	50	41	7
42	5	1	42	...
43	1	10	43	...
* 44	...	...	44	5
45	6	30	45	...
46	7	80	46	...
47	11	50	47	...
48	4	15	48	10
49	7	50	49	...
50	7	60	50	...
51	14	50	51	...
52	11	20	52	...
53	7	5	53	...
54	7	20	54	...
55	8	25	55	...
		2,044		1,142

* Either produced no flowers or flowered very late in the season.

NOTES.

Karachi Milch Cattle.—This question has been re-opened by the holding of the first cattle show for these cattle in conjunction with the Agricultural Show at Landhi Farm in January 1915.

The real milch cattle are only found in the Karachi tract which is not alluvial or at least has not been laid down by the Indus. In this tract there is little cultivation but good grass grows after rains. The tract extends from the west border of the Indus delta to the Kohistan hills and across the Hub river into Las Bela State.

The cattle owners often with 5 or 6 cattle apiece unite under a *zemindar* and form a temporary village within easy reach of Karachi. In this village the milch cows and calves are kept. The milk is taken every day and in some cases twice a day by camel to Karachi to the *bania* who retails it. The milk forwarded is credited to their account at a few annas per seer less than the market rate. The *bania* gives them bran, rice bran, cotton seed, gram husks and cleanings from *dhal*, etc. This is taken back daily on the return journey. The cattle are put out to graze in the mornings even when owing to long absence of rain the country looks absolutely bare. They are brought in at mid-day and the mixture of bran and grain put into a tub and made into a sloppy *mash*. This grain stuff is, needless to say, charged by the *bania* at rates much higher than the current market quotation.

The dry cows and young stock are either 'sent to Sind' as the owners say, *i.e.*, to Indus delta, or towards the Hub and Kohistan to pick up what grazing they can get.

The owners are not cultivators and grow no grain or fodder crops of any kind. After good rain the grass springs up very quickly

and is of excellent quality but the rainfall being only about 10-15 inches per year is much too uncertain to give a constant supply of grass.

As far as the question of Karachi milk supply is concerned the present arrangement seems to be much preferable to keeping large number of cows in dirty hovels stall-fed and without exercise as can be seen in Bombay, etc. The cows are in the open and exposed to the sun, they get much exercise and the milk produced seems to be entirely free from danger of serious septic contamination. Of course when it is being retailed in Karachi, dirty water, etc., may be added. There are also some dairies in Karachi itself to which the above remarks do not apply.

There are no figures available to show what yield of milk a good cow will give in one lactation period. In the Poona Civil Dairy 2,000 ℔. is said to be the average for Sindhi cows but as the conditions under which the cows are kept in this dairy are as different as they possibly can be from those prevailing in Sind this figure can have little value. Daily yields of 3 gallons are common with 4 per cent. butter fat.

It is undoubtedly a fact that there are some excellent stock but it is a moot point whether there are any owners who are constantly breeding from their best animals only. It is probably a fact that a stud bull being sold at a good price a cheap poor animal is produced in his place.

There is a big demand for good Karachi cattle. They are exported to Ceylon, Straits Settlements, and other parts of India and to Japan and the Colonies. There are several regular exporters who buy in Sind and Las Bela. Prices have risen rapidly. Fifteen years ago a good cow could be bought for Rs. 50, and now Rs. 500 have been offered for the best.

A good milch breed is a valuable asset to the country and it seems the general opinion that the best of Karachi cattle are being denuded by the export trade, and that deterioration has set in. Whether this is so or not it would seem that the breed stands in great need of some systematic work being carried out in its native country. In the writer's opinion this need would best be met by the

establishment of a stock breeding and dairy farm somewhere near Karachi.

The land for the farm would have to be fairly level, free from *kalar* and with subsoil water near the surface. The soil in the Karachi tract is generally of a light sandy nature and quite favourable for growing good fodder crops as maize, *guar*, berseem and lucerne. With water within 10 feet of the surface a supply of green fodder could be cheaply grown all the year round with water pumped by an oil engine from open or tube wells. One hundred acres of well cultivated fodder crops would be ample for a stock of 30 cows with young stock and bulls. The necessary buildings could be cheaply erected with iron work and corrugated sheets. About 200 to 400 acres in addition of rough grazing would also be needed. This would provide ample exercise and good grass after the rains.

The site would be a matter for consultation with the local authorities. Such land could probably be obtained in the Gadag plain. At present it is only grazing land and not cultivated, so it could be acquired at a small cost.

To stock the farm, young stock about 2-year old would be the cheapest to buy and these well fed up should produce good material to work from.

When the farm is in a working basis the milk would be sold in Karachi and a supply of good bulls would be available for the various herds. The farm should show a return on the capital expenditure.

The great benefits of such a farm would be the possibility of selection on the basis of the milk yields and butter fat which would be accurately kept. At present there are no data to go on.

The proposed farm could either be in the sole charge of the Civil Veterinary Department or in the conjoint charge of the Civil Veterinary Department and the Agricultural Department. The establishment of an efficient stock farm seems to be the only means of meeting an urgent need, placing a few stud bulls at various points in the district would have little or no effect on the situation.—[G. S. HENDERSON.]

CHICORY, A DANGEROUS WEED IN BERSEEM.—Berseem (*Trifolium alexandrinum*) is gradually finding favour as a cold season fodder crop in widely separated parts of India, and since it was introduced from Egypt a few years ago, notes have appeared in periodicals and reports recommending the clover to stock-keepers. But insufficient notice has been taken of Chicory (*Chicorium Intybus*) a deep-rooted perennial herb, which is a gross and abundant weed in Berseem crops produced from Egyptian seed. And as very little Berseem seed is harvested in India, and Chicory appears to be always present in imported seed, it behoves those who grow Berseem in India to weed out Chicory rigorously, especially where Berseem is permitted to ripen seed, for this deep-rooted perennial herb, like most of the *Compositæ*, produces a great quantity of seeds which are readily dispersed. When it is established, Chicory is even more difficult and expensive to eradicate than *Carthamnus oryacantha*.—[W. ROBERTSON BROWN.]

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In the *Annals of Applied Biology*, Vol. I, Nos. 3 and 4, Dr. C. A. Barber has contributed an article touching some of the difficulties which are met with in the improvement of Indian sugarcanes. It is well known that by far the larger part of the sugarcane crop in India is grown in the North where the canes are inferior, and the question naturally arises whether improvement may not be obtained most rapidly and economically by replacing them with better kinds. Dr. Barber discusses the four different ways in which this may be done.

"(1) *The introduction of exotic canes which have proved of value elsewhere.*—This method has been the main line followed for many years all over India, from Madras to Peshawar. Thick, tropical canes, the relics of successive importations, are everywhere met with. But it is generally found that these thick canes have not time to mature in the north during the short, hot, moist period. They sometimes grow surprisingly well and are full of juice, but the ripening process by which the glucose is changed to crystallisable sucrose is arrested and, although extensively used as fruit and eaten raw, these thick exotic canes are generally useless for the manufacture of sugar.

PLATE XX.

Part of a field of Berseem (*Trifolium alexandrinum*) at Peshawar. Photographed 15th. June 1913. Temperature in shade on date 115° F. Four cuttings were taken between Nov. & June. Seed was sown on 15th. Sept. Crop cut for seed end of June.

It is possible that certain early maturing varieties may still be met with, or that changes in treatment may lead to improvement along this line and this is not being lost sight of, but we have the advantage of actual demonstration of their behaviour all over the country and the prospect of success is not encouraging.

(2) *The transfer of canes from one part of India to another.*—This method of improvement is well known to the cultivator. He is not only accustomed to the trial of new varieties valued elsewhere, but is acquainted with the advantage of occasional change of seed in the same variety. Exchanges of varieties are being actively carried on by the Agricultural Departments of the various Provinces and occasional advantage accrues from this. Collections of different varieties of sugarcane growing together are a constant feature on local farms. The fine new canes introduced into Madras through the Samalkota farm are now to be met with in every part of India, even extending to the North-West Frontier Province. But success along this line is limited and, in the main, the introduced kinds cannot hold their own against the best local kinds, the latter themselves being the outcome of centuries of selection by the cultivators.

(3) *The improvement of local canes by selection and the observation of sports.*—This method has perhaps hardly received the attention during recent years that it undoubtedly deserves, but there are special difficulties in the way with a crop that can only be finally judged after it has passed through the mill and been chemically analysed. The sugarcane has, from time immemorial, been propagated by cuttings, and it is difficult to determine whether chance variations in growth are or are not due to better local treatment or feeding.

(4) *The production of seedlings.*—This has been tried many times in India, but in the past always unsuccessfully. The experiments have not always been conducted very carefully, and on the founding of the new department it was decided to examine the matter afresh and try to determine the cause of failure in the face of the successful results obtained in Java, the West Indies and elsewhere. The solution of the problem turned out to be remarkably simple. Almost all the experiments were made in North India and it transpires that the stamens do not mature and pollen is not

formed in the cane flowers there. A cursory glance showed that this was not the case in South India, and in the Government farm opened at Coimbatore in the Madras Presidency, some 40,000 seedlings have been raised during the past two years."

The chief problem, that of obtaining seedlings, has in the main been solved. But a number of difficulties have cropped up which Dr. Barber has detailed in that article in the hope that help may be available from the great body of those interested in plant-breeding. These difficulties have been admirably summarized in the *International Sugar Journal*, June, 1915, which has published this article in an abridged form. We reproduce them *in toto* for the readers of this Journal.

Briefly stated these difficulties are as follows :—

"The lack of control of the flowering; there is no means at present of inducing the canes one is most interested in to flower. This arrowing of the cane is comparatively rare in North India though it occasionally occurs over large areas. It is believed to be commoner in years of drought. The available data suggest that in India the flowering ensues whenever the flow of sap is interfered with, whether by the paucity of water or the unhealthiness of the root system.

"Then there appears to be a very close relation between richness and purity of juice and the vigour of growth, only unfortunately the two appear to be in inverse proportion, the smallest and most meagre seedling canes having the richest juice, and the most vigorous ones the poorest. Yet the main requisite in a seedling is not only high percentage of sucrose and purity of the juice but also a large quantity of sugar.

"Then there are difficulties in selecting suitable parents and inducing them to flower together. Is it possible to ensure that the seedlings obtained are real crosses and not the results of self-fertilization? And is it possible to decide the parentage of seedlings by observing their subsequent habit and growth? For this purpose a very complete knowledge of the morphological difference of the parents is required. Some progress has been made already at the Indian experiment stations by recording a remarkable number of

minute distinguishing characters of different canes. The work is still far from complete ; but a natural system of classification is being attempted in which the members of the different groups resemble one another in as many as possible of the standard characters. In such a system agricultural, botanical and chemical characters will all have a place.

" Arising out of this there is the question, are these characters constant in different localities and under diverse conditions ? And of what value are the standard characters in separating seedling canes ? Are any of the minute differences observed in varieties propagated vegetatively handed down unaltered in seedlings derived from them ?

" Taking all these uncertainties into consideration and there are naturally many chemical and agricultural ones not yet fully grasped—the main line of work in the cane breeding station for the present is considered to lie in the direction of selecting suitable parents, preserving the healthy offspring of the best of these, analysing the juice after the first year's growth and observing the relative vigour of growth and choosing the best for further observation—a narrowing circle in which ultimately a few of the best all-round will remain to be sent to the chain of agricultural stations in the north for a renewed series of tests there, before dissemination among the cultivators."

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In the *Scientific American*—from the annual report of the Bureau of Soils of the Department of Agriculture, U. S. A., one gets a simple method for use in checking soil erosion in gullies. This is done by building a dam across the gulley with a sewer pipe fixed through the bottom of the dam connected with an upright pipe which passes up to the top of the dam. This allows the flood water when it reaches sufficient head to pass quietly away while all the soil and sediment settle round the pipe against the dam and help to repair the former damage by steadily refilling the gulley. A tile field drain will get rid of the water impounded against the dam. By this method erosion is stopped and the water is robbed of all its silt while the eroded gullies are gradually filled up. It would seem well worth while trying this method out here, if a practical American could be got to manage the work.—[WYNNE SAYER.]

In the April (1915) number of the *Bulletin of Agricultural Intelligence and Plant Diseases, Rome,* there is a note on the results of crossing a Gujerati bull with the Maremma, Romagnola and Perugia breeds. This bull aged $3\frac{1}{2}$ years weighing 1,430 lb. served 113 cows between November, 1912, and May, 1914, and out of these only 9 came back to him—a pretty convincing proof of his value as a stock getter.

The notes on his progeny are of course more or less limited as it is really practically impossible to state the actual value of a bull in terms of the stock he has got until he has been dead some years, unless he is kept on for a long time, which is impracticable in a small herd as his daughters would have to come to him unless there was room for another bull.

Nevertheless the following points appear to be prepotent in the cross:—

1. The Gujerati is dominant in fineness of skeleton, abundance of dewlap, development of the ear, slope of the rump and muscular system.
2. The coat-colour and size of horns are recessive.
3. All crosses show great agility in movements and great robustness.
4. Much aptitude is shown by all crosses as flesh producers.
5. A hereditary resistance to foot-and-mouth disease is also plainly shown. This last character should prove invaluable in view of the scourge this disease is on the continent.

The chief interest in the note, however, rests on the fact that if Indian cattle prove of value for crossing only in this last respect—immunity to foot-and-mouth disease, a great export market may open and the question of the export of the best Indian cattle will then become of great importance.—[WYNNE SAYER.]

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In the *International Sugar Journal* for June, 1915, there is an interesting note on molasses as a source of alcohol for the production of power, reviewing a paper on the subject read by Mr. T. H. P. Heriot of Glasgow before the Scottish Section of the

Society of Chemical Industry. Alcohol's suitability for generating power is well known everywhere now. And in most cases its production from starch or cellulose renders it necessary to charge the capital cost of the original crop plus its raising, harvesting and transport to the distillery against the cost of the alcohol which as a natural sequence is bound to be high; whereas by the utilization of that great factor in economical production the by-product, alcohol can be made from molasses and all the above costs charged against the sugar which has to pay them any way.

We are then presented with a cheap source of alcohol which is only limited by the sugar production and it is reckoned that when the present rate of efficiency of extraction (it is now only some 14 per cent.) is brought up to its proper level some 200 million gallons of alcohol will be made available from the world's beet and cane molasses.

Now as the cost of the raw material works out at between nil and 4*d.* per gallon according as to whether it would be thrown away or used for other purposes it is obvious that a great deal more can be done in this direction both as regards increasing and cheapening the output.

It is therefore evident that this represents a considerable opening for a fresh source of income and profit to the sugar industry but steps must be taken to relieve alcohol of the present harassing excise duties under which it labours in most countries and when it is made clear that alcohol is being more used in the capacity of an invaluable motive power agent than in its old *rôle* of incapacitating the human agent under the heading of a luxury for which it is rightly taxed, it is hoped it will not be long before the present restrictions are removed.—[WYNNE SAYER.]

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The presentation of the final report of the Royal Commission on Sewage Disposal (in England) renders it advisable to review the entire position of things as regards the use of sewage sludge as manure. The inhibiting factor for general adoption of sewage as manure is the fact that as a water-borne system of sanitation is now

almost universally prevalent, large quantities of liquid have to be dealt with and, as even the best adapted soils can only effectively absorb small quantities, a considerable area of land is necessary, and distributing the sewage in this fashion does not seem to have been a commercial success.

"Sludging" (collecting the finely divided matter in suspension by sedimentation and pressing it into cakes after mixing with lime) is another method of dealing with it, and in this state it is sold at 6*d*. per ton or given away.

Objection has been taken to its smell when applied to the fields in this condition, but this objection pales to insignificance compared with the smell produced by fish offal and other compounds regularly applied in some districts. The crux of the matter appears to be that this sludge does not produce any stimulation of growth which will in any way repay its application in large quantities, and it seems obvious that the nitrogen and phosphoric acid of sludge are in a much less available form than the same substances present in sulphate of ammonia, super-phosphate and fish meal. Natural sludge contains 10 to 15 per cent. of grease and soapy matter which appears to hinder its ready decomposition into an available condition; and it is obvious from the following experiments that the effect of sludges on land is almost negligible.

Treatment	Yield of Hay per acre cwt.
Untreated	17·64
Natural sludge	18·64
De-greased sludge	16·29
Calcium cyanamide	21·59
Nitrate of soda	25·93

This would seem to point to the fact that the removal of the fat does not increase the ease of decomposition and this is borne out by Rothamsted experiments.

The point to which laboratory and other experiments might in future be directed seems to be the discovery of some means of rendering the nitrogenous matter of the sewage sludge more readily available as plant food than at present.—[WYNNE SAYER.]

In the *Veterinary Journal* (London) of July, 1915, there is an interesting note on " Repellents for Protecting Animals from Flies " which should be of particular use and interest in this country where the fly displays such a lively interest in all live-stock.

Four flies are given—the stable fly, *Stomoxys calcitrans ;* the horn-fly, *Lyperosia irritans ;* the screw-worm-fly, *Paralucilia macellaria ;* a blue bottle-fly, *Lucilia sericata.*

Flies against which stock require protection are of two kinds, those of the bot variety which lay their eggs in wounds and those which bite. But the losses among cattle from biting flies are not great.

Certain colours are said to repel flies, and it is a well known fact that light-coloured animals suffer less from flies than dark.

Potassium tellurate was recommended by Ochmann as an internal remedy, but Mayer failed to obtain results with this remedy, and it would seem safe to assume that internal remedies will never prove practicable in repelling flies.

Various oils are also used both pure and in emulsions and in mixtures. Fish oil is rated as one of the best, and while Jensen's formula of crude petroleum in emulsion and powdered naphthalin is said to protect cows for a week, the protective action of fish oil is said to range from less than two days to a maximum of six days. Laurel oil combined with linseed oil in proportion of 1—10 was found by Mayer to protect for from two to twelve days. These would seem to be of use for horses and draught cattle, but it is a question whether they could be successfully used with a milch herd, bearing in mind the extraordinary way in which turnips will affect the taste of milk. No suggestion is put forward as to how they do it ; as this controversial matter has been argued for so long any further statement is unnecessary, but on the face of it one cannot believe that the taste of fish oil or crude petroleum would be long absent from the milk.—[WYNNE SAYER.]

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In the *Journal of the Royal Lancashire Agricultural Society* for 1915 there is an interesting article on " Succulent Foods and their importance in Milk Production." While undoubtedly the

beneficial results of succulent foods are widely known among all who have to do with cows, yet there are hints contained in the article which may not be already known to all. Grass of course is the cheapest and best food at the farmers' disposal, and it is a pity that so many farmers prefer to use concentrated foods to make up for grass deficiency when they would obtain much better and more lasting results by the judicious use of artificials on their existing pastures.

It is wonderful what 2—3 tons of lump lime per acre will do in cleaning off lumpy herbage. Basic slag at the rate of 10 cwt. to the acre on clay, or steamed bones 4—5 cwt. per acre on light land, will bring about a great improvement in the quality of the grass.

Thus by judicious use of manures on grass a large amount of the feeding which at present falls on the arable land might be avoided and the stock might be maintained for longer periods and in better condition. There is little doubt that the difference in feeding value of different fields would well repay investigation. In Romney Marsh for instance there is a well-known case of two fields close to each other, in the same position as regards drainage and aspect, on both of which the grass seems equally good and thick. But while one will only *maintain* a certain quantity of sheep, the other will fatten three times the number. It is therefore obvious that a great source of income and a great source of supply is at hand, only waiting for some definite line of investigation to be started to find out the best feeding grasses and the conditions under which they do best, and having found this out the knowledge will result in the improvement of thousands of acres which are at present only producing some 30 per cent. of their capabilities.—[WYNNE SAYER.]

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There is an interesting note on "The Composition and Value of Liquid Manure" in the *Journal of the Board of Agriculture*, London, July, 1915, in connection with a bulletin on the subject published by the North of Scotland College of Agriculture, in which an account is given of the results obtained by a series of experiments on the hay crop. The value of liquid manure has long been realized, but its conservation in a proper state is so dependent on proper

drainage of buildings and yards that it has up till very recently always been allowed to run off to waste, and add its stimulating qualities to the farm drinking water by finding an ultimate haven in the local pond.

It is of course dependent on the amount of water given to the stock, such foods as concentrateds, hay, and other dry stuffs will naturally produce stronger liquid manure than a turnip diet which musters some 90 per cent. water.

The following experiments give some interesting results and when one comes to take into careful consideration the time of application along with the amount applied, one is apt to come to the conclusion that frequent dressings throughout the season are best for practical purposes.

	Time of Application	Weight of Hay per Acre
		lb.
Untreated	......	4,512
2,000 gal. per acre	December	5,557
2,000 ,, ,, ,, ...	January or February	5,768
2,000 ,, ,, ,, ...	March	5,610
1,000 ,, ,, ,, ...	December }	5,719
1,000 ,, ,, ,, ...	March }	
2,000 ,, ,, ,, ...	December } ...	6,075
2,000 ,, ,, ,, ...	March }	

From the financial point of view, valuing the hay at 51*s*. per ton, (hay has been at £4—£6 per ton frequently in last few years, so this estimate is well below) the application of 2,000 gallons of liquid manure produced about 25*s*. per acre increase and increased value of aftermath, say 5*s*., and if the unexhausted value of the potash is taken at 8*s*. per acre, the return is some 38*s*. against an estimated value of say £2 as is to be seen from the following table.

The weight of 1,000 gallons of liquid manure would be about 10,000 lb. or nearly 4½ tons. This quantity would contain:—

Nitrogen, about	20½	lb.
Phosphoric Acid, about	3	,,
Potash	46¼	,,
Lime	2	,,

The content of nitrogen would be equal to that present in 100 lb. of sulphate of ammonia, and, on the basis of 7*d*. per lb. of nitrogen,

would have a value of 12*s*. The potash is more than that present in 3 cwt. of kainit, and at the pre-war price of 2*d*. per lb. might be valued at 8*s*. The value of the phosphoric acid present would be about 7*d*., while the lime would have practically no value. Liquid manure as collected in the North-East of Scotland would, therefore, have a value of about 4*s*. 6*d*. per ton as manure, reckoning the potash at pre-war prices, or of about 6*s*. 3*d*. per ton, assuming potash to have doubled in price.

The dressing of 4,000 gallons per acre did not show a sufficient increase on the extra 2,000 gallons to warrant a dressing above 2,000.

The liquid manure should be put on some three weeks before cattle are turned in as it fouls the grass for a time but its stimulation of a new growth would soon do away with this.—[WYNNE SAYER.]

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Helopeltis antonii as a pest on nim trees.—It is a familiar sight during the months of January and February to find around Coimbatore most of the *nim* trees (*Melia azadirachta*) presenting a very distressing appearance. Whether young or old, whether they are in an avenue or growing by themselves in fields, they are equally badly affected. With the leaves on the twigs withered into a yellowish brown and drooping down in an unnatural manner, the trees look as if they had been struck by lightning or scorched by fire. Though in many cases only isolated twigs or often one or two of the bigger branches are thus affected, it is not uncommon to find trees where, without an exception, all the branches are thus attacked. In such extreme cases the attack looks so severe that the looker-on would naturally expect to find them quite dead in a short time, but contrary to all expectations, the dead leaves drop off, fresh shoots appear, and later on abundant blossoms burst forth, so that the trees seem to take on another lease of life.

The affected shoots present a characteristic appearance. The whole twig is dead and dried up, and is, instead of the greenish brown of the healthy shoot, of a dull yellow-brown colour with several large patches of darker brown. Quantities of gum that has oozed out from punctures or fissures in the affected bark are

found attached in small lumps to the dried up twig. The apical shoot, as well as the side-shoots that appear later on, are all found completely dried up. If it be a bad case a whole branch may thus dry away. When the entire twig is dead the cause of such wilting is hard to find since at that stage none but a few saprophytic fungi are noticeable. The examination of a few green twigs of an affected tree—preferably tender shoots—will be enough to enable one to find out what the real author of the damage is and how it causes the injury.

Life-history of the pest.

The real offender is a slender bug of moderate size possessing a remarkable resemblance to certain Ichneumon wasps. It is on the whole dark brown in colour, with the head, eye and the long antennæ black, the thorax bright reddish orange, and the wings smoky brown and with a large bright and conspicuous greenish white band covering more than half the surface of the abdomen. The presence of a scutellar horn—a long club-like structure rising from the scutellum—is an unmistakable feature of this genus of bugs.

These bugs may be found singly or in pairs on the twigs of affected trees. The fertilized bug seeks fairly young shoots and stabs the soft tissues with the aid of her sabre-like ovipositor, and deposits her eggs in the wounds thus caused. The egg is pale blue in colour, cylindrical but curved, rather bulged posteriorly and narrowed anteriorly and ending in an oval depressed lid on a level with the surface of the bark. When the shoot is tender the egg is deeply imbedded in its tissues, and when it is hard, is inserted between the bark and the wood. The egg is entirely concealed from view and can be detected only by the presence of a pair of unequal, curved, hair-like filaments rising from and guarding the anterior end.

The eggs are usually laid in groups of two. A single female secured from the branch of a *nim* tree, laid, under confinement in a cage, about 32 eggs in the course of four days. It is likely that more than 50 eggs would be found to be laid by a single female under natural conditions.

Eggs laid on 6-7 April 1915, hatched on 12-13 April 1915 so that the egg in this case took 6 days to hatch.

The very young nymph is slender, reddish or yellowish brown in colour and possesses an uncanny appearance with its long spiny legs and hairy body. The young bug sucks the sap from the tender shoots, and where the proboscis pierces the bark, the young tissues all round are killed and a discoloured patch is formed. Gum oozes out later on from the punctures made by the bug.

There are apparently five moults. The club-like structure is not present in the young bug and makes its appearance only during the later instars.

The damage done to the shoots is very much out of proportion either to the size of the bugs or to their numbers—the largest number ever found on one twig being not more than five. The bugs seem to inject some secretion through their proboscis which kills the tissues all round.

Food Plants.

At Coimbatore this bug has been noticed attacking Mahogany and Guava to some slight extent. At Udipi, in South Kanara District, it was collected on certain wild bushes.

In Ceylon it has been recorded by Mr. Green attacking Tea, Cacao, and Cinchona.

Occurrence through the year.

On *nim* trees at Coimbatore, the main attack seems to occur between December and February, dried twigs being most numerous and conspicuous about February. The trees shed their leaves about the beginning of March, fresh shoots appear soon, and later on the flower-buds. These enable the pest to pass through a generation or two, so that fresh cases of wilting twigs are seen in April and are prominent till the end of May. By the middle of June the dead leaves drop off, and as the monsoon breaks fresh shoots appear. These do not appear to be infested, and except for a few stray young bugs the pest seems to vanish. It is probable that it does not reappear till October.

Distribution.

Coimbatore is so far the only place where it has been definitely proved to occur as a pest on *nim* trees.

Typically damaged trees were noticed by the writer in November, 1909, about Dindigul, while travelling by train. Similar trees were noted in June, 1915, at St. Thomas' Mount near Madras. In this latter locality several dead twigs were examined, and though the characteristic symptoms such as the presence of exuded gum and the dark patches were present, no traces of the pest were noticeable excepting in one case the half-mutilated moulted skin of a bug. St. Thomas' Mount or its vicinity will therefore have to be visited once again, at a time when *nim* trees have tender shoots, before it can be determined with certainty as to which insect was responsible for the wilted twigs.

Mr. S. Sundararaman, First Assistant to the Government Mycologist, Madras, informed the writer that wilted twigs are common on *nim* trees in Tanjore. Mr. C. Narayana Ayyar, Third Assistant to the Government Entomologist, Madras, has observed wilted twigs on *nim* trees in Madura District, and recently in June in South Malabar.

So far as known to the writer, similar wilting does not occur anywhere in the Ceded Districts.

It is therefore evident that the available knowledge of the distribution of this insect as a pest on *nim* trees is very scanty; it may, however, be presumed that it will be found all along the country adjoining the Western Ghats and possibly also along the plains on the East Coast.

Remedial measures.

When large trees are concerned spraying would be so costly that treatment would be prohibitive. In the case of small trees, however, spraying with a contact poison may be very useful, since the young bugs, being rather delicate insects and far from being very active in their movements, will be destroyed by the spray. No treatment would be of any use if done late in the season

when the bugs have disappeared after doing the damage. Spraying should be attended to, as soon as the first cases of wilt are noticed.

As even in extreme cases the trees recover from the damage very soon, the attack is not really very serious, and energetic measures do not therefore seem to be called for, unless it is desired to protect any particular trees for any peculiar reason.—[Y. RAMACHANDRA RAO.]

[*Helopeltis antonii* is figured in *Some South Indian Insects* (page 488. fig. 374) where its distribution is given as "Coimbatore, and probably throughout the Hills of Southern India" and its food plants as "Mahogany, Persian *Nim* (*Melia azedarach*), Tea, Cacao, Cinchona, Annatto (*Bixa orellana*")—ED.]

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Storage of fodder against famine.—While the necessity of fodder storage against times of famine in tracts of precarious rainfall which are far removed from any forest reserve or other place where grass is obtainable is acknowledged by almost all cultivators many of them do not store fodder as a provision against bad years owing to the risk of fire or theft or for some other reason but merely trust to chance or some other agency to help them to tide over the period. Government have been supplying jungle grass from their reserved forest areas for a long time. But a considerable portion of such grass is generally of poor nutritive value and is eaten by cattle in some districts only when they are starving. Further, this grass has to be transported very long distances at great cost, when the pressure on the Railway rolling-stock is very heavy. In Bombay the question was discussed to see whether any satisfactory scheme could be devised by which Government or any other organized body could improve upon existing arrangements.

A scheme for the storage of fodder against famine proposed by the Director of Agriculture has been approved by the Government of Bombay.

The conditions likely to lead to a successful working of any such scheme are that the fodder should be stored in the midst of localities subject to famine and also should be such as the local cattle are accustomed to eat, it should be machine-baled and portable in case it is necessary to transport it to any distance, and it must also be

possible for the scheme, while modest in an experimental stage, to be capable of expansion if found successful on trial. The Director of Agriculture therefore proposed that the Agricultural Department should grow, shred (when necessary), bale, and store fodder at the following places each year and hold up the fodder for use when a fodder famine next occurs:—

Nadiad Farm (Kaira Dist.) *Kadbi* 330,000 ℔.
Kopargaon (Ahmednagar Dist.) Do. 1 million ℔.
Chharodi (Ahmedabad Dist.) Grass 1 million ℔.

These places have been selected because of their proximity to areas which are liable to fodder famine. In addition to this it was suggested that in good years when the price of *kadbi* is very low the Agricultural Department should purchase, shred, bale, and store about one million ℔. *kadbi* in a suitable place in the Dharwar District. In parts of that district *kadbi* is lavishly used in years of plenty and much of it finds its way to the dung heap. But in other localities *kadbi* will have to be specially grown under irrigation as ordinary local supplies are hardly sufficient.

It has been estimated that the cost of stored fodder in times of famine will not compare unfavourably with the total cost at which it has been found possible in the past to make jungle grass of poor quality available in the affected parts. In storing fodder in large quantities the dangers of fire, thefts, and white ants have to be guarded against. The fodder is also liable to deterioration if stored over a long series of years. The Department will be able to overcome the first set of difficulties, while as regards the latter it is believed that the shredding and baling of *kadbi* can be undertaken successfully, and that hay and *kadbi* retain their nutritive properties for some years when properly stored, *e.g.*, under a 'Dutch barn.' The fodder stored by the Department will be very useful in parts where the fodder difficulty is chronic and in others in times of famine, and if no fodder famine occurs in the near future the small cost can be taken as an insurance charge. A 'Dutch barn' capable of holding $12\frac{1}{2}$ lakhs ℔. power-baled fodder or 7 lakhs ℔. hand-baled fodder costs about Rs. 17,000. A complete shredding and

baling plant with all accessories costs about Rs. 5,600 to purchase and set up.

It was suggested by the Director that with an additional allotment of Rs. 10,000 he would be prepared to make a modest start at Nadiad and Kopargaon. This sum was accordingly provided by the Local Government in the budget for 1915-16. The work will be developed as funds permit.

The object of the scheme is to facilitate and improve the fodder supply operations which Government finds it necessary to undertake in times of fodder famine. It is not intended that the cultivator should consider that he is absolved from undertaking any private storage in his own behalf.

The Director observes that in suggesting that the work shall be undertaken in the first instance by the Agricultural Department and that the experiment shall be made mainly with *kadbi* it is not intended to suggest that no other agency or material would be suitable. If any individual body or company were prepared to take up the work on suitable lines with or without a subsidy or guarantee the work could be transferred to them. Similarly though *kadbi* seems to be the most promising fodder to take as a basis, it will be desirable to look for other grass areas where the work proposed for Chharodi may be duplicated and to consider the possibilities of other feeding material and mixtures. The present scheme has been put forward with a view to making a start at once. It will no doubt be an interesting experiment from several points of view.—[EDITOR.]

REVIEWS.

A Note on Well Boring.—By W. M. Schutte, Agricultural Engineer to the Government of Bombay. Bulletin No. 68 of 1914, issued by the Department of Agriculture, Bombay. Printed at the Yeravda Prison Press, Poona. Price, As. 5 or 6*d*.

In this note Mr. Schutte strongly advocates the use of drilled wells or borings as being more sanitary and less expensive than the old-fashioned excavated well; he also discusses the conditions necessary for "Artesian" supplies of water, and gives brief particulars of the various methods of boring he employs.

The author gives two very interesting statements which show the relative cost of irrigating sugarcane in five districts, by means of the *mhote* as compared to irrigation by a centrifugal pump.

These statements should prove of considerable value to cultivators who are considering the advisability of installing power pumps, as they show that in one of the five districts power pumps are twenty-five per cent. cheaper, while, in the remaining four districts the saving is from fifty per cent. to seventy-five per cent. in favour of power pumps.—[T. A. M. B.]

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We have received from the Director of Agriculture, Madras, a printed copy of the Proceedings of the Agriculture and Trade Conference held there in December last. The opening speech of H. E. the Governor which appears at the beginning explains the object and methods of the Conference. The subjects considered were cotton, groundnut, wool, manures, implements, well-irrigation by power, jute, coconuts, tobacco and sugar. All papers under each subject head are collected together on an ordered plan, first come the names

of those who attended the meeting, then the notes prepared for the use of those invited to be present, and finally the summary of the discussion which ensued. The notes presented on each subject are very valuable, and are as full as they could possibly be. A perusal of the book should give the reader a clear idea of the present position of the Departments of Agriculture and Industries with regard to each of the subjects discussed and should also indicate the lines of advancement which seem most suitable. The holding of Agriculture and Trade Conferences is much to be commended as they bring the Government Departments and representatives of the trade into close touch, a matter that deserves every encouragement. It would have been an improvement had the publication been given an Index, and it is hoped the Director of Agriculture will see his way to supplying this want in the next issue.—[EDITOR.]

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Alkali or Kalar Experiments and Completion Report of the Daulatpur Reclamation Station, Sind.—BY G. S. HENDERSON, N.D.A., N.D.D., Deputy Director of Agriculture, Sind. Bulletin No. 64 of the Department of Agriculture, Bombay. Printed at the Government Central Press, Bombay. Price, As. 14 or 1*s.* 4*d.*

This publication is interesting because it provides detailed information as to the nature of the original soil, the method of reclamation, the crops grown and the financial results. The farm was a square of about 400 acres of "Kalar" land with a fall of about 4 ft. in its breadth, and required some levelling. It was started early in 1908 and was sold at the end of 1913. The first consideration is the nature of the salt present. This consisted principally of sodium chloride; calcium sulphate and magnesium sulphate or chloride were also generally found, and calcium chloride was frequently present; sodium carbonate was absent and the bi-carbonate was only present in nominal quantities. Thus it was "white" alkali and indicated that the soil would be readily permeable to water and the salts consequently readily washed out.

The land was divided into squares of about 1·5 acres each and canal and drainage channels constructed.

The canal water obtainable was not sufficient for flooding or for rice cultivation ; at first the allowance was 3 cusecs, which was subsequently increased to 5·5 cusecs.

The crops grown were principally berseem (Egyptian clover) and cotton, together with small areas of rice, *sawan*, *jowar*, *bajra*, maize, wheat and gram.

Berseem grew well generally, but cotton did indifferently until 1913 when the American cotton succeeded.

So far as reclamation is concerned the experiment has been most useful and shows that alkali land of this nature offers no real difficulty provided water is available. As could be anticipated from the chemical examination, the soil was permeable to water, and given a sufficient supply of the latter element, purification of the soil was certain. The open drains proved to be unnecessary, for the water percolated downwards freely and did not come out into the drains.

Regarding the financial aspect, the balance sheet showed, when the farm was sold, total expenditure Rs. 39,881 ; realized on sale of crops, bullocks and land Rs. 30,610 ; loss Rs. 9,271. The land realized only Rs. 25 per acre. Thus according to the balance sheet such land has not been reclaimed and sold at a profit. At the same time it must not be overlooked that the land was improving each year and an actual profit of Rs. 2,110 was made in the last year of the experiment. The chief value of the work, however, lies in the fact that we have definite evidence that such land *can* be made culturable. The cost of initial experiments is always high.—[J. W. L.]

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War on Weeds.—By FARMER GILES, Author of "Manures and Manuring," "The Potato Book," etc. Published at "The Smallholder" Offices, 16-18, Henrietta Street, Covent Garden, London, W.C. Price, 6*d*. net.

The Editor of the *Smallholder* has sent an interesting little booklet entitled "War on Weeds" for review in this Journal. It strikes one as an exceedingly concise and complete manual on weeds

and how to deal with them and in particular one is struck by the commonsense method which the author has adopted of giving a short article on the losses caused by weeds at the commencement of the book. One of the measures advocated by the author to deal with weeds is to organize local campaigns carried on by school boys and girls who could easily in their spare time destroy a large number of weeds. He also advocates the passing of an Act such as is in force in the colonies, *e.g.*, Transvaal, New Zealand, South Australia in which the compulsory destruction of such weeds as are dangerous will be provided for. There is little doubt that most of the 'dirty land' of the present time was caused by one year's neglect in the past, and if it could only be clearly brought home to the general public that the relaxation of their efforts for one year means the necessary redoubling of them for the next seven to get the land clean again, we should not find the cases which are so common over all agricultural land of several farms which are kept clean being resown with weeds every year from one dirty farm in the neighbourhood.

2. It may be argued that India does not need to worry about weeds, and that though "The Coorg Noxious Weeds Regulation" was passed in 1914 to deal with "Lantana," still there is as yet no general legislation on the subject, but it should be clearly borne in mind that with the example of the damage done by the spread of "Lantana" in Coorg and parts of Mysore every effort should be made by the cultivator not only to deal with the existing weeds but to take steps to prevent at the outset the spread of any strange weed which may be introduced either by accident or experiment and find the place to its liking. To draw a rough parallel one has only to speak to the Australian about rabbits or to the Wisbech fruit farmer about gooseberry mildew to learn in a few words what harm these casual experiments can do; and it would seem to be all the more necessary because these parts do not happen to be really infested with any particular weed that the greatest care should be taken to prevent the intrusion of one like the aforementioned "Lantana," which was introduced into Coorg and Mysore some fifty years ago as an ornamental plant for gardens, and spread so

greatly that in 1906-07 it was estimated that some 184,000 acres or some 19 per cent. of the whole area of Coorg were covered by this noxious weed, which has destroyed the grazing grounds and crops and seriously damaged the timber in the reserves by its liability to catch fire at the least provocation. In face of these facts too much care cannot be taken, and a book dealing with Indian weeds in the same way might well repay writing and publishing.

A reference to the statement of objects and reasons of the Coorg Noxious Weeds Regulation will show what damage a weed of this kind can do if allowed to go unchecked for a comparatively short time in this country. [W. S.]

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Use of Water in Irrigation.—BY SAMUEL FORTIER, D. SC. Published by Hill Publishing Company, Ltd., 6 and 8, Bouverie Street, Fleet Street, London, E.C. Price 8*s*. 4*d*. net.

This book meets a long-felt want of the agriculturist in supplying numerous details of farming by irrigation in the United States.

The young settler taking up land will be well advised to study this treatise, from which he will obtain much valuable information regarding the selection of a farm under irrigation, and the procedure to be followed to ensure water rights.

Full particulars of the methods of laying out lands, the construction and maintenance of the necessary ditches and channels to obtain economical distribution of water, and various methods for measurement of water applied to the fields are described.

The author shows the various methods of irrigation best suited to the raising of different crops under several conditions of soil, climate, location, etc., and the quantity of water required to yield maximum returns, when applied in conjunction with field cultivation which his vast experience has proved to give the most satisfactory results.

Details of cost in each of the western states are given for clearing, ploughing, levelling, grading and constructing water courses, etc., and for making and laying concrete, iron and timber pipes and

flumes for water distribution, and also the total cost for the raising of various crops and the market rates obtainable for these.

Numerous dimensioned illustrations are given of the implements found most suitable for ditching, scraping, levelling, etc., and as these are of simple design and constructed chiefly of timber, they can in many cases be made on the farm. Detailed illustrations of various types of flumes and regulating devices are shown and descriptions of the method of construction are most complete.

Although "Use of Water in Irrigation" deals primarily with farming in the United States, its study will prove of considerable advantage to irrigation farmers in other countries.

The particulars given of underground distribution for irrigation, overhead spraying and pumping from the subsoil, show that with proper supervision farming may be a profitable undertaking in spite of considerable expense in distribution, and even when subsoil water has to be raised from a depth of 300 to 400 feet.

We consider that "Use of Water in Irrigation" will be of more than passing interest to agriculturists in all countries and congratulate its author in providing a guide to the young settler and experienced farmer alike.—[T. A. M. B.]

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Investigations on Usar Land in the United Provinces.—BY J. W. LEATHER, F.I.C.—Printed at the Government Press, Allahabad, 1914.

Under the above title the United Provinces Government Press has published three reports by Mr. Leather on investigations into the nature of the salts that cause infertile patches in land under irrigation in the United Provinces, and into the effect, on the distribution of these salts, of changes of season and of treatment.

In a Memoir on the "Loss of Water from Soil during Dry Weather" (*Memoirs of the Department of Agriculture in India, Chem. Ser.*, Vol. I, No. 6), the author described the boring tool with which samples of soil are taken for examination. He also showed that the drying effect of the whole of a dry season on a fairly permeable soil at Pusa was not sufficient to cause any appreciable

reduction of moisture below the 7th foot from the surface, beyond that due to drainage, and could not therefore have been effective in raising any considerable amount of water from below that depth.

In the present papers Mr. Leather describes a new method devised by him for comparing the permeability of different soils by water under gravity; and puts on record a large number of data showing the seasonal, horizontal, and vertical distribution of salts and of moisture, down to a depth of 9 feet, in selected patches of such "alkali" land, including some which have been under experimental treatment for a number of years.

These data enable a very good idea to be formed of what actually does go on in "alkali" land, and probably to a less degree in all alluvial land with a high water table under conditions of excessive surface evaporation.

The typical alkali patch in the United Provinces appears to be a mass of relatively impervious soil extending to the surface and surrounded by soil that is more permeable. The rain, for the most part, runs off the surface of the less permeable soil and drains away through that which is more permeable and which is thus kept free from any accumulation of salts. On the other hand, the subsoil water obtains free access to the impermeable mass through the more permeable soil by which it is surrounded and is constantly drawn up by surface tension, and evaporated at the surface, leaving any contained salts behind it.

The rate of evaporation of water and accumulation of salt appears to be slow, but it is not quite clear that the author is correct in applying the same reasoning to these scarcely permeable soils as can be relied on in the case of the more permeable soil dealt with in the Memoir referred to above. Permeability under pressure would seem to be quite a different thing from permeability under the influence of varying surface tension, and the author hardly appears to give sufficient consideration to the possibility that very minute differences of moisture-content in a homogeneous, relatively impermeable soil may cause a flow of water rapid compared to the flow that could be induced by the pressure of a few inches of water on the surface of the same soil.

The net result of the author's investigation is to show that, in the case of a soil that is hardly at all permeable to water under pressure, little can be done to make it fertile except in so far as the surface can be broken up and rendered more pervious, so that drainage can take place to a certain depth. This has been successfully done by Mr. Keventer at Aligarh by thorough cultivation and heavy manuring. But the author says :—" Less than 1 foot has been changed physically and made freely permeable to water. Only one conclusion can be drawn in respect of this experiment, namely, that the topmost soil has been reclaimed and that the crops which are annually produced live almost entirely on this stratum; a conclusion which is supported by the fact that the crops require *constant* (weekly) irrigation."

Mole draining, which is being tried with some success in the Punjab, is probably a more effective way of doing the same thing to a greater depth, and if the interval between successive irrigations can be extended in the same ratio as the depth to which the soil broken up is increased by using the mole plough as compared with methods of surface cultivation, the saving of water by the cultivation of these heavy lands would provide a considerable fund to pay for the cost of mole drainage.

The work recorded in these papers may be said to have established scientifically the fact that the only practicable way of rendering fertile, tracts in which alkali is due to the impermeability of soil which extends to the surface, is to break the soil up as deeply as possible and maintain it in constant cultivation under irrigation.

Having thus—by spade work of which it is not easy to appreciate the full value—cleared the way for subsequent workers, the author has added one more to the list of similar services which he has rendered to Indian Agriculture.—[A. C. D.]

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We have received from the Indian Cotton Oil Co., Ltd., of Bombay, a booklet entitled " Cotton Seed Products in India." In

this booklet after a brief and lucid description of their plant and methods of obtaining raw material, they make clear several matters regarding the value and uses of cotton seed—particularly the fact that the increase of cotton and decrease of wheat will not act adversely on the cost of living. They clearly point out the value of cotton seed and its by-products and take this opportunity of emphasizing the fact that cotton seed oil is equal to the best *ghee* and only the customs of antiquity prevent it from being regarded as a formidable rival to *ghee* in the open market; that not only does the seed produce this most valuable oil but also the hulls or husks form a most valuable and cheap cattle food which rivals *kadbi* and a series of experiments have been made which fully bear out the Company's contentions. The question of cotton cake is also dealt with and a good many of the prevalent superstitions (for one can call them nothing else) with regard to cotton cake are finally run to earth. The difference between the cost of decorticated and undecorticated cotton cake is explained on the basis of their feeding values which is the only satisfactory way of making this point clear to the general public, finally the value of cotton seed products as manure is mentioned, and it is clear from a perusal of this extremely well-put-together booklet that the advantages of these products as claimed by the Company are no mere advertising clamour but a clearly worded statement of facts. Attention is also drawn to the extremely interesting way in which the chemistry of oils and fats is dealt with, making this subject, which has always been one reeking of possible and impossible compounds and wrapped in a haze of formulæ terrifying to the uninitiated, quite simple and readable for the ordinary agriculturist. The whole booklet shows signs of the undoubted energy and business capabilities of the Company who should meet with every success as they appear to manufacture the right thing, to know it and to be quite determined that all India shall also share in the benefits. A lot of the paragraphs which deal with the cattle foods and feeding would well repay printing in the Vernacular for general distribution to the cultivators. The book can be obtained post free on application to the Company.—[W. S.]

Note on the Level of the Water in the Sub-soil of the Gangetic Plain.—By E. A. Molony, I.C.S., Commissioner of Agra. Bulletin No. 33, Agricultural Series, of the Department of Land Records and Agriculture, United Provinces. Price, As. 2.

In this note the author discusses the water-supply, in the sub-soil of the Gangetic Plain; and its equilibrium as maintained by surface absorption of rain and irrigation water on the one hand, and drainage through the sub-soil into rivers and wells on the other.

The object of the note is apparently to call attention to the necessity of maintaining the sub-soil water-level by artificial means, to compensate for the effects of drainage operations and well irrigation.

In many districts, of course, canal irrigation acts as an effective preventive of any such fall in the sub-soil water-level, and the Public Works Department no doubt already takes the question into consideration in estimating the area ultimately to be served by any new canal, so as to avoid the water-logging that has occurred in some districts. But the subject is one of great importance, with the elements of which all interested in Indian Agriculture should be familiar, and this note, by the author of the well-known Manual of Irrigation Wells, published as Bulletin No. 22 of the United Provinces Department, should do much to keep the question in the view of those responsible for the initiation of public works.

The author hardly seems to attach sufficient importance to irrigation and cultivation as methods of conserving the sub-soil water. He, to some extent, deprecates the drainage of swamps, as tending to diminish the supply available for soakage, but apparently does not take into account the effect of cultivation of the swampy area in diminishing evaporation and in preventing the formation of an impervious layer of silt and thus promoting free drainage into the sub-soil of such water as may still have access to the land: it is probable that the greatest loss of water from a swamp is usually through evaporation, not by soakage.

The author suggests driving tubes down to sandy strata through the beds of swamps, and the provision of a filter, at the top of each tube, which could be kept clean so as to maintain a continuous

rapid flow into the sub-soil. This would no doubt be practicable if a sufficient cavity, to allow of rapid percolation, were first cleared in the sand at the bottom of each tube, but the expense of maintenance of the very large filter area necessary would be considerable.

A simpler way of maintaining the sub-soil water-level when canal irrigation is not possible, would seem to be to create shallow artificial monsoon swamps, on selected sandy surface soil, by making low contour bunds, with slightly elevated water channels where necessary. These swamps could be cultivated for paddy ; or used merely as reservoirs during the monsoon, and cultivated in the cold weather on the same principle as the land enclosed by "rabi embankments" as described by Evans in the *Agricultural Journal of India*, Vol. VIII, Part II, April, 1913. Excellent crops could be raised on such land, fertilized as it would be, annually, by a deposit of fine silt. A general survey would be necessary to locate suitable sites, but in the alluvium, as Mr. Molony says, "the layers of clay are very seldom continuous for any considerable distance, but resemble islands of clay placed at various depths and surrounded on all sides by a great sea of sand" and there should be little difficulty in locating numerous suitable sites for rapid absorption of surplus water.—[A. C. D.]

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Practical White Sugar Manufacture.—By H. C. Prinsen Geerligs, Ph.D. (London, Norman Rodger, St. Dunstan's Hill, E.C. Price, 12*s*. net.)

This publication is one of a series on sugar manufacture that have been issued in recent years by the same author.

One of the most pressing problems at present engaging the attention of sugar manufacturers is the production of white sugar for consumption direct from the cane. Owing to the invariable presence of reducing sugars and other substances liable to cause coloration of the juice during evaporation, the manufacture of white sugar from cane presents difficulties that are not met with in Beet countries.

The success of white sugar manufacture depends on the treatment of the raw juices in such a manner that complete clarification is obtained without the formation of decomposition products of glucose, and other substances causing the objectionable coloration of the juices.

Those engaged in working up cane juices know only too well the care that must be exercised to keep the temperature low while the juice is alkaline with lime during clarification.

The old and well established methods of clarification, *viz.*, the various methods of sulphitation or bleaching with a solution of sulphur dioxide gas and the carbonatation methods are fully described and criticized. The latest and most up-to-date modifications of the various processes are also dealt with in detail, and as many Indian factories have still something to learn about these methods, this publication will doubtless be greatly appreciated by the practical sugar man.

In the manufacture of white sugar as Dr. Geerligs remarks the disposition of the plant and the ability of the employees counts for much more than the choice of any one of the processes in use.

Even the best process will fail where the machinery is inadequate or the men incapable.

The careful education and training of the men is indispensable and the fault of having overlooked this point has repeatedly been the cause of failure where success was anticipated.

As has already been stated, the old established processes of carbonatation depend on preventing the coloration of the juice while alkaline with lime by keeping the temperature low. One process described in this book aims at the complete destruction of the reducing sugars by heating with a large excess of lime before treatment with carbon dioxide gas. This process known as the Battelle process—may be described as bold and daring, but it is stated to give an almost colorless juice quite free from glucose.

As the glucose is destroyed at the commencement of this process it is immaterial whether the juice is subsequently heated and evaporated with a faint alkaline reaction.

The Battelle process appears to be always carried out in conjunction with the recovery of sucrose from dilute molasses by a process involving the use of ice and it is not likely to be adopted in India at present. It is interesting, however, as it shows that the Sugarcane Technologist is not going to rest satisfied with the present methods and is attacking the problem of white sugar manufacture in a bold and scientific manner.—[G. C.]

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Yearbook of the U. S. Department of Agriculture, 1914 (Pages 715, Plates 53, Figs. 45. Price, 75 cents. Washington Government Printing Office, 1915).

Maintains the interest of its predecessors—an interest which to those outside the States consists chiefly in the record of the progress of American agriculture towards better and more intensive cultivation.

The strong point in American agriculture, as in all American industries, has always been the output per head—the high rate of wages obtainable. The rise in prices in recent years is now favouring an increase of output per acre, and in the resulting combination of intensive cultivation with extensive methods in American farm practice, lies the promise of a solution of the problem of widening the now narrowing margin between the rate of agricultural wages and the cost of the necessaries of life all the world over.

The wheat crop of 1914 in the States was opportunely a record one, both as regards acreage and yield per acre, and, with the prospect of over 25 per cent. being available for export, goes far to allay the anxiety that was felt some twelve years ago when the States seemed to be on the point of becoming importers of wheat. Next to irrigation among the means of this increased production, the most important place should probably be given to the introduction and spread of wheats better adapted to the varied conditions of different parts of the country. An article in the yearbook gives an account of the great success that has attended the introduction from Western Siberia of a 'durum' wheat which not only produces a much larger crop than other wheats in dry localities, but now competes with the best Manitoban wheat for the highest price in the world's markets.

The supply seems to have created the demand, millers having apparently found the wheat useful for mixing with others owing to its good yield in the milling process and the capacity of the flour for absorbing water.

Owing to the rise in the price of meat in the States, great efforts are being made to increase the home supply. On this question the Secretary of Agriculture says in his Report "Unquestionably the largest hope for a considerable increase in our meat supply lies in four directions: first, in a more satisfactory handling of the public grazing lands; second, in systematic attention to the production of beef animals in the settled areas of the country, particularly in the South; third, in increased attention to the smaller animals, such as swine and poultry; and fourth, in the control and eradication of the cattle tick, hog cholera, tuberculosis, and other animal diseases and pests."

There is little doubt but that these efforts will be attended by success similar to that which has been achieved in other directions; and though a still more rapid increase in the consumption of food in the country is probable in the future, owing to the great increase of immigration that will almost inevitably follow the present European war, yet there seems to be little reason to fear that a surplus of agricultural produce will not be available for export from the States for many years to come.

A welcome feature of these successive annual reports is the growing recognition of the fact that the great results achieved are due not so much to new scientific discoveries as to the application of scientific method in the adaptation of old lore to new conditions.—[A. C. D.]

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A Note-Book of Agricultural Facts and Figures.—By R. Cecil Wood, M.A. (Printed at the Government Press, Madras. Price, As. 14.)

This little book received from the Madras Department of Agriculture is based on the famous one by McConnell to be found in use all over England, will fill an equally useful purpose for South India, and one would suggest that if each Local Government

were to have a similar manual compiled for use in their own province much material help would be afforded to those whose work is in the agricultural circles. It enables one to put one's finger at once on many vital and essential facts in connection with Indian agriculture and were everybody familiar with the facts as given therein, it would tend to a higher standard of general efficiency in practical agriculture. The section on manures is particularly good and the diagram (which the reviewer took at first sight for a map of the Coimbatore farm roads and buildings) showing which manures should not be mixed and which may, will serve a very useful purpose and save much trouble and expense. We would, however, suggest that coloured lines be used in the next edition as conveying a clearer idea ; red is generally used as indicating disaster and green safety. In short, we would recommend this little book for perusal by all as it gets closer to the all-important *practical* side of agriculture, a side all too liable to be neglected for the *theoretical*, and every credit is due to the author for collecting a mass of valuable information and doing a lot of spade work which will be of infinite help in the future and, like all work of this kind, will probably not be properly appreciated in the present.—[W. S.]

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